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THIRTY-FIRST ANNUAL REPORT

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

OCTOBER, 1893.

BOSTON:
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Commonwealth of Massachusetts.

MASSACHUSETTS AGRICULTURAL COLLEGE,
AMHERST, Oct. 15, 1893.

To His Excellency WILLIAM E. RUSSELL.

SIR: — I have the honor herewith to transmit to Your Excellency and the Honorable Council the Thirty-first Annual Report of the Trustees of the Massachusetts Agricultural College.

I am, very respectfully,
Your obedient servant,

HENRY H. GOODELL,
President.

ANNUAL REPORT OF THE TRUSTEES

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

His Excellency the Governor and the Honorable Council.

In obedience to the requirements of chapter 440, section 5, of the Acts and Resolves of 1889, we herewith present the Thirty-first Annual Report of the Massachusetts Agricultural College. Being made in October instead of January, it will consequently cover only nine months of the fiscal year, and three months of the new school year. We would earnestly recommend such legislation as will enable us to make this report December 31 instead of October 15, for the following reasons: That an agricultural college cannot close its experiments, records and expenditures before the close of the year; that endless confusion would arise in the treasurer's report from carrying over the receipts and expenditures from one year into another; and that the State Experiment Station does not close till December 31, and our relations with it are so close as to require this change.

The year elapsed has been perhaps the most prosperous one in the history of the college. It is a noticeable fact that in times of financial depression the numbers of college students increase rather than diminish, and this year has been no exception to the rule. The great universities have been full to overflowing, and never has there been so large an attendance here. The entering classes numbered sixty-six and the full enrollment reached two hundred and fourteen. A smaller per cent than usual have been non-residents of the

State, while those from Massachusetts have been more widely distributed. One hundred and thirty-six towns are represented. This is in itself an encouraging sign as showing that the college and its opportunities are being more generally and favorably known.

The instruction has been more satisfactory in all departments because of increased facilities. The large additions to the equipment and apparatus and the increase in the teaching force have been important factors in bringing this about. It is, perhaps, too soon to judge of the effect of making the studies of the senior year elective. But this much can be said: It has met with universal favor among the students themselves, allowing them a greater freedom in choosing those subjects in which they were more particularly interested. The stimulus thus given is very noticeable, and we are persuaded that a higher and more excellent grade of work will be secured. It has been said that the aim of every good teacher should be "to interest by attraction and not by compulsion; to draw and not force." If this can be obtained through the pupil himself, a two-fold result will inevitably follow, affecting scholar and teacher alike. The growing interest and eager questionings of the former must react on the latter and result in fresher and more original instruction. From the nine studies allowed for choice, certain groups of three naturally followed. Comparing them we find that out of a class of thirty-one —

Thirteen elected agriculture, political economy, veterinary.
One elected agriculture, chemistry, veterinary.
One elected agriculture, chemistry, political economy.
Three elected botany, entomology, German.
One elected botany, chemistry, electricity.
One elected botany, mathematics, German.
Four elected chemistry, veterinary, political economy.
One elected chemistry, mathematics, German.
One elected chemistry, entomology, electricity.
One elected chemistry, mathematics, political economy.
One elected chemistry, political economy, German.
One elected veterinary, political economy, German.
Two elected electricity, mathematics, political economy.

Again arranging the studies in the order of their preference, we find that —

Twenty-three elected political economy.
Twenty elected veterinary.
Fifteen elected agriculture.
Eleven elected chemistry.
Seven elected German.
Five elected botany.
Four elected entomology.
Four elected electricity.
Four elected mathematics.

The shorter two-years course, opened for the first time this year, seems to be supplying a long-felt want. Twenty-three availed themselves of its advantages. Inquiries are still frequent for a short winter course in agriculture and horticulture alone. While this might be made profitable, it is impracticable with our present corps of instructors. They all now have more work than good teaching justifies, and with the increasing demands of the two-years and elective courses their time would be fully occupied without taking upon themselves anything more.

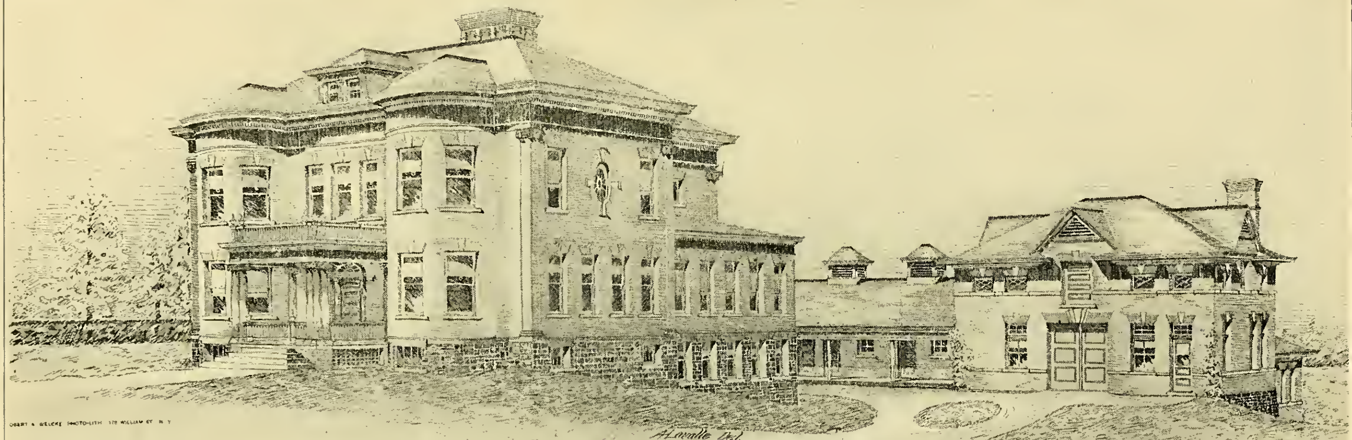
The Faculty.

The several changes made in the curriculum have necessitated additional help, and five assistant professors have been appointed in the departments of chemistry, agriculture, mathematics, English and botany. Edward R. Flint, a graduate of the college in 1887, post-graduate at the State Experiment Station, 1887–90, and student at Goettingen, 1890–92, receiving from that university the degree of Ph.D., is giving instruction in chemistry. Fred S. Cooley, a graduate of the college in 1888 and for some years superintendent of the farm, has been made assistant in agriculture. A. Courtenay Washburne, now filling acceptably the position of assistant in the chair of mathematics, was educated at Purdue University, La Fayette, Ind.,and at the United States Military Academy, West Point; was for two years assistant city civil engineer of La Fayette, Ind.; has been employed as

commandant of cadets and professor of mathematics in the New York Military Academy at Cornwall-on-Hudson, the Chiltenham Military Academy, Ogontz, Pa., and the St. John's Military School, Sing Sing, N. Y. He has also taught in the Ogontz School for Young Ladies and in the Ossining Ladies' Seminary at Sing Sing. Herman Babson, graduate of Amherst College, 1893, has been assigned as assistant in the English department, and George E. Stone, student at the Massachusetts Agricultural College and Institute of Technology, Boston, and subsequently at Leipsic University, where he received the degree of Ph. D., has been appointed assistant in botany. One more assistant, in the department of languages and natural history, should be appointed as soon as practicable. It is not possible for the president to teach two and three hours a day and at the same time carry on effectively the administrative duties of his office. The professor of natural history is now teaching all that it is wise for him to undertake, and the establishment of the two-years course will add materially to his duties.

State Appropriations.

The money appropriated last year by the Legislature for the erection of new barns and for other needed improvements has been partially expended in accordance with the provisions of the resolve. The foundation walls of the new structures have been laid in a most thorough and satisfactory manner by the Flynt Brothers of Monson. The framework will be entirely set up and roofed over before the setting in of cold weather, and the work carried forward to completion during the winter. The wooden floor, so long needed, has been laid over the hard concrete of the drill hall, and the breaking of the gunstocks and the annoying dust raised by the cadets in their evolutions will be largely prevented. The room formerly used as a chapel has been entirely remodeled and fitted over as a laboratory for advanced students. It will provide additional accommodations for about thirty, and is furnished with fume chambers, water, gas, lockers, sets of reagents (wet and dry) and all the accessories necessary for the proper equipment of a laboratory.



·VETERINARY·LABORATORY·AND HOSPITAL·STABLE·
·AT·THE·MASS. AGRICULTURAL·COLLEGE·
·AMHERST·MASS.
·E·A·ELLSWORTH·ARCH'T. HOLYOKE·MASS·

Dormitories and Recitation Rooms.

The increased attendance has taxed to the utmost the capacity of the dormitories. At the close of the school year there were but seven vacant rooms left with which to provide for the entering classes, numbering sixty-six members. In a very few cases, and those only with the consent of the occupants, three were placed together, but by far the greater proportion were compelled to seek for lodging places in the town, at a considerably greater expense to themselves, and often at so great a distance as to seriously inconvenience them in their attendance upon required duty. Next year it will be scarcely possible to accommodate those now in college, without taking into account those about to enter. A possible solution of this difficulty may be found in the efforts of the secret fraternities to purchase property and erect chapter houses outside the college limits. Each one of these will set free from eight to a dozen rooms. The D. G. K. society has already bought and remodeled a house, making provision for fourteen of its members. The Phi Sigma Kappa has purchased land, and but for the panic of the last few months would probably have commenced building before this. Other societies are moving in the same direction. Whether it is wise, in the crowded condition of our dormitories, to await action that may be delayed several years is doubtful. A more serious problem, however, confronts us in the lack of recitation rooms. Including the laboratories connected with the different departments, we have only nine available rooms. In these nine rooms during this term there are being held daily thirty-five recitations, five of them being double hours, necessitated by work in the laboratories. With the coming in of an additional class next year in the two-years course the number of recitations will be increased to forty, six of which will be double hours. Certain studies, as of the languages, for example, can be taught in any room, but there are others in which instruction can be given only where the appliances used in illustration are to be found. Chemistry cannot be divorced from the laboratory, botany from the greenhouse and museum, or physics and mechanics

from the apparatus room. This fact has added greatly to our perplexity in assigning hours and places for recitations. Again, the lecturer requires time and space to arrange his apparatus and go through with his experiments beforehand, and it is well-nigh impossible to do this while the room is occupied by another class. It has been a very difficult matter to so adjust the term schedule of exercises as to prevent collision. With five additional recitations to provide for, we cannot see how this can be accomplished without friction and interference. In this dilemma, we can only emphasize the words used in a former report — the twenty-eighth: —

> The most pressing need of the college at the present time, in connection with its educational department, is a building to be used as an economic museum, with laboratories and recitation rooms annexed, which shall illustrate the departments of agriculture, veterinary science, entomology and geology. Aside from the great value as an aid to instruction in the class-room, it would serve as an object lesson to every visitor coming to the college.

If such a building was necessary then, how much more is it needed now, with an increased attendance and additional classes! It would at once provide the requisite rooms, and bring together under one roof all collections bearing upon the science of agriculture. Take for example the single item of implements. What an instructive lesson if there could be grouped together working models illustrating their history and progress! To the agriculturist at the World's Fair one of the most interesting exhibits is that made by Cornell University, of some hundred or more models of ploughs, showing the improvements that have been made since the days when a stick hardened in the fire or tipped with iron was in vogue. Already a commencement has been made here, and collections have begun to grow. There is a fine set of implements illustrating Japanese agriculture, a collection of soils, with their analyses, and thirty to forty statuettes of types of the domestic animals, from one-sixth to life size, imported from Germany. At the present time these have to be stored wherever a place can be found for

them, to the great inconvenience of the lecturer as well as the great risk to the specimens themselves.

The Botanical Department.

The partial separation of the horticultural department from the botanical has been of great benefit, allowing Professor Maynard to devote himself to the former, and carry on the lines of work in which he has been so successful. The large collection of fungi, numbering some two thousand species, and the Denslow collection, of more than ten thousand species and varieties of phanerogamic and the higher cryptogamic plants, are being remounted and catalogued under the superintendence of Dr. Stone, and the whole is being made available for study and comparison. The vineyard and nurseries are in fine bearing condition and have yielded heavy crops of grapes, pears, peaches and plums. The committee from the Massachusetts State Horticultural Society appointed to decide on the merits of out-of-door gardens awarded the college vineyard this year the first prize of $50.

The Agricultural Department.

The work of the farm has been conducted on the same plan as in previous years, and I herewith submit the report of the professor in charge: —

Farm Report.

The year 1893 has thus far been an unusually favorable one on the college farm, in spite of the fact that our rowen and fodder crops have been seriously injured by the almost unprecedented drought of the late summer and autumn months. The average health of our live stock has been higher than for several years, and there have been few casualties. The crops of the year, in part estimated because of the early date at which this report is required, show a higher aggregate value than last year, which in its turn exceeded that of any previous year. The figures for this year are $6,955, exclusive of soiling crops, which it is believed by the close of the season will have aggregated 258 tons, which are estimated to be worth $774, thus raising the total to $7,729, against $6,660 for the year 1892. The hay crop, in spite of drought, is rather larger than last year; the potato crop, on one and one-third

times the acreage, is about three times as great; and other crops have been raised to about the same amounts as last year.

The cash receipts of the first nine months of the year amount to about $4,463. Besides this we have done work with men and teams on the new barns to the aggregate amount of $1,586.63, which sum should be repaid to the farm when the balance of the State appropriation becomes available. No part of our potato or squash crop has yet been sold; and we have also nine fat hogs and twenty-five head of neat cattle to dispose of before the close of the year. The leading items which have contributed to our cash receipts during the year have been cream and milk, and hay, corn and potatoes raised last year.

The number of acres in the various crops of the year is as follows: Hay, 75; field corn, 24; corn for fodder and silage, 10; potatoes, 13; oats and peas, 3; oats and vetches, 3; oats for fodder and hay, 11; beets, $2\frac{1}{4}$; Swedes, $\frac{3}{4}$; carrots, $\frac{1}{2}$; squashes, (grown after rye), 1; millet, 5 (two grown after rye); rye, 3; barley and peas, 4 — a total of $155\frac{1}{2}$ acres, or, deducting land which produced two crops, $152\frac{1}{2}$ acres. As our crops show an aggregate value of $7,729, we have an average yield amounting to $50.67 per acre. In obtaining these figures hay has been valued at $16 per ton, green fodder at $3, silage at $4, corn stover at $8, beets at $3, carrots at $12, Swedes at $5, and squashes at $20. Potatoes have been valued at 50 cents per bushel and corn at the same price. It is believed that these prices are not too high in any instance, while it is fully expected that the potatoes will bring considerably more than they have been valued at.

In view of the fact that this report is required before the operations of the year are brought to a close, it is not deemed best to go into great detail concerning the several crops. Our general management has been similar to that for the last few years. Our land is, as a rule, fall ploughed, manured during late fall and winter, and, if sod, prepared for seed in spring by the use of disc and Acme harrows. If stubble, it is lightly reploughed in spring. With the manure we use more or less fertilizer, harrowed or drilled in at time of planting. During the past season the policy, in which I thoroughly believe, of using undissolved phosphate, instead of the much more costly superphosphates as the source of phosphoric acid, has been inaugurated. We have applied about three hundred pounds of South Carolina rock phosphate to every acre under cultivation in hoed or sown crops. Knowing, however, that this phosphate could not be depended upon to feed the crops of this year, we have used superphosphate also to a considerable extent.

The experimental work for the past few years in the agricultural department of the Hatch Station has made so evident the relation between the supply of potash in the soil and the growth of clover and other legumes that I have felt it to be wise also to use fertilizers supplying this element in abundance. Accordingly, large amounts of muriate of potash have been applied to nearly all our fields, except that in which potatoes were grown, and here we made a liberal application of the sulphate of potash. The policy outlined has made necessary an unusually large expenditure this year for fertilizers, no less than $1,515.25 having been expended for fertilizers and payment of freight on the same. We have, moreover, kept more stock of all kinds than ever before, and have therefore made a large quantity of manure; and as we feed to our stock considerable purchased grain and other concentrated food-stuffs, it will be seen that our land should be greatly increased in fertility as a result of the operations of the year. It is confidently expected that the crops of another year will show that such is the case.

The manurial treatment of our crops may be of interest and is shown below: —

Applications per Acre.

	Old Mowings.	Field Corn.	Silage Corn.	Potatoes.	Beets.	Swedes.	Millet.	Squashes.	Oats and Oats with Peas and Vetches.
Manure, cords,	–	4	4	4	–	–	–	6	–
Nitrate of soda, pounds,	150	100	125	125	150	150	100	100	150
Plain superphosphate, pounds,	–	200	300	400	300	500	300	200	200
South Carolina rock phosphate, pounds,	–	200	300	300	300	300	300	300	300
Dried blood, pounds,	–	–	100	–	–	–	–	100	–
Tankage, pounds,	–	–	–	–	150	150	150	–	–
Bone meal, pounds,	86	–	–	100	100	100	100	–	–
Muriate of potash, pounds,	150	150	150	–	250	250	175	100	150
Sulphate of potash, pounds,	–	–	–	300	–	–	–	–	–

The land in carrots received the same fertilizer as that in beets. On a part of our beets we used 200 pounds of common salt per acre in addition to the above.

An effort has been made to help our students, as well as the visiting public, by posting conspicuous placards in every field, stating the kinds and amounts of manures and fertilizers used, the date of planting the seed and the variety.

I have been frequently asked why I charge hoed and sown crops noticed in previous reports with only one-half the manure and three-fourths the fertilizer applied. My answer is that our land is under a rotation system, an essential feature of which is two or three years in grass without manures, except possibly a little nitrate of soda in early spring for the second or third year. This application of nitrate of soda would be very small, perhaps 125 to 150 pounds per acre, and costing only about $3 or $4. With such manuring as we practise I look for an increase in the hay crop of about two tons per acre, when land is reseeded, over what it would have produced if it had lain in grass without manure. This increase in the hay crop more than covers the part of the manure and fertilizer not charged to the hoed crops, and all the time the land is increasing in fertility, as will be evident from the following statements and calculations: —

We broke up a meadow in the fall of 1890 which was yielding about one ton of hay per acre. This field was planted to corn in 1891 and 1892, and seeded to grass and clover sown in the corn the latter year. The proportion of the manure and fertilizer applied to the corn crop in these two years which was not charged to that crop was worth $23.74 per acre. Reseeding cost $4.50. The nitrate of soda to be applied next spring will cost $3; making a total of $31.24 against the field. This year we got three tons of hay per acre from this field; next year I confidently expect as much. We have then six tons of hay in the two years, certainly four tons more than the land would have produced had it lain in grass during 1891 and 1892 without manure. This four tons of hay is worth to us standing in the field not less than $32. Meanwhile how has the land fared? The receipts and expenditures of plant food are shown below: —

	Applied in 1891 and 1892.			Removed in Two Corn Crops, 1891 and 1892.		
	In Manure, Pounds.	In Fertilizer, Pounds.	Total Pounds.	In Grain, Pounds.	In Stover, Pounds.	Total Pounds.
Nitrogen,	368	41.25	409	113	111	224
Potash,	333	132	465	27	150	177
Phosphoric acid,	196	48.25	244	37	31	68

* If there has been no waste, the land in the two years has gained plant food as follows: Nitrogen, 185 pounds; potash, 288

* For details as to amounts of manures and fertilizers applied and crops harvested the reader is referred to the college reports for January, 1892 and 1893.

pounds, and phosphoric acid, 176 pounds. The teaching of science is that we shall find practically all this potash and phosphoric acid in the soil, but that some of the nitrogen may have been washed out. Since, however, I have always sown a crop in the standing corn in August which has continued to grow until late in fall — in other words, a nitrogen conserving crop — and since, further, most of the nitrogen applied has been in the form of the organic compounds of fresh cellar manure, I believe that a large share of this also remains in the land to help our hay crop. Now let us see what the expected increase — viz., four tons of English hay — will remove from the soil. According to the analyses of Dr. Goessmann it will contain: Nitrogen, 112 pounds; potash, 124 pounds, and phosphoric acid, 21 pounds. The surplus left by the two corn crops was: Nitrogen, 185 pounds (to which we propose to add 25 pounds in the nitrate of soda to be applied next spring); potash, 288 pounds, and phosphoric acid, 176 pounds. Does it not appear, therefore, that the land is growing richer and that I am justified in having charged the corn crops with only one-half the manure and three-fourths the fertilizer used?

I must add that the calculations upon the amounts of nitrogen, potash and phosphoric acid in our manure are based upon the average result of six analyses of our cellar manure; and that the fertilizers applied were all analyzed. There appears, therefore, no reasonable ground for doubting the accuracy of the work.

Labor Cost of Crops. — The labor cost in raising our leading crops may be of interest, and this I am able to give, since accurate account of the time spent on each is invariably kept. The figures given below show the cost per acre of each of the crops mentioned up to the time of harvest: Silage and fodder corn, $11.34; field corn, $10.61; potatoes, $12.39; beets, $36.

The work, in so far as practicable, is done by horse power, the cultivation being almost entirely accomplished by the use of the smoothing harrow, Breed's weeders and different cultivators. Prout's horse-hoe was used with great satisfaction in hilling potatoes.

The labor cost of putting our corn into the silo, the haul being about one-half a mile, has this year amounted to 80 cents per ton. The cost of digging our potato crop, 3,500 bushels on a little less than 13 acres, has been $178, or about 5 cents per bushel. We have used Hallock's potato digger, but the potato hook has been required also; as the digger, although it turns out practically all the crop, leaves many tubers, large as well as small, covered with earth.

Farm Live Stock. — The fact that the health of our farm stock has been generally good has been alluded to. I regret to report that our sheep appear to constitute an exception at the present time to this general rule. They are considerably affected with grub in the head, the larva of a small gadfly (*Œstrus ovis*) which is deposited upon the nostril, "whence it creeps into the nasal sinuses." Five sheep have been lost from this trouble, which appears singular, as it does not usually cause such serious consequences. We appear to be for the present powerless, as the most effectual remedies for this disease are preventive, the best authorities agreeing that little in the way of treatment is possible, though in the case of very valuable animals the bones of the face may be trephined and recovery follow. We have had fewer cases of tuberculosis and abortion among our neat cattle than for the last few years, the breeding increase being very satisfactory.

The reception of a pair of Tamworth pigs, through the generosity of J. Montgomery Sears of Boston, has given us the chance to inaugurate an interesting experiment in breeding. We have crossed the small Yorkshire with that breed. The pigs are still young, but give promise of proving a very useful type, something between the excessively small bone and superabundant fat of the small Yorkshire and the coarse bone and lean, narrow body of the Tamworth.

Returns from the Dairy. — The average number of cows milked during the year thus far has been thirty-five, exclusive of those in process of drying off. The gross returns for cream, milk and calves have been $2,149.61, an average of $61.42 per cow in full milk. The whole number of milch cows kept has averaged thirty-nine animals, and the average return per animal has been $55.12. The skim-milk being included at 2 cents per gallon, the figures per cow become, respectively, $72.84 and $65.11 for the nine months.

Our stock at present consists of the following animals: —

Horses: Percherons, 1 stallion, 1 mare, 1 stallion colt and 1 mare colt; 1 three-fourths Percheron mare; 1 half-blood Percheron mare; 3 geldings, 2 mares and 1 three-fourths Percheron mare colt. Total, 12.

Cattle: Ayrshire, 1 male, 11 females; Holstein-Friesian, 4 males, 16 females; Jersey, 1 male; Guernsey, 1 male; grades, 52 females. Total, 7 bulls and 79 cows and heifers.

Sheep: Southdowns, 2 rams, 24 ewes and 4 ram lambs. Total, 30.

Swine: Small Yorkshires, 3 breeding sows, 18 pigs and fat hogs; Tamworths, 1 boar, 1 breeding sow and 8 pigs; Tamworth-Yorkshire, 6 pigs; grade Chester White, 9. Total, 46.

Equipment. — The chief additions to our equipment made during the past nine months are as follows: One two-horse dump-cart; "Superior" land-roller (iron); Mekenney's "Acme" broadcast fertilizer-distributer; Thompson's wheelbarrow grass-seeder; Prout's horse-hoe; Breed's "Universal" weeder; Zephaniah Breed's weeders (two styles) and Deering's "Giant" mower. These machines and implements have all given good satisfaction. The fertilizer-distributer fills a long-felt want, as by its use we are able to secure much more even distribution of fertilizers than is possible by hand work unless the workman is unusually skilful as well as careful.

Improvements. — One-half an acre of land has been cleared of stumps, a large number of boulders and loose rocks have been removed from our fields, and we have built a substantial bridge with stone abutments and a good road across the foot of the ravine; but most of our surplus energies have been expended in excavation, grading and hauling stone for our new barns. In this work nearly all our teams and several men have spent most of the time since July 25. Our total expenditure in their work, as elsewhere stated, has amounted to over $1,500. But for this work we should have been able to make much greater progress in the permanent improvement of our farm.

The New Barns. — Of these it is not best to say much at this time. Much care has been taken in planning them, and it is believed sanitary requirements will be much more fully met than in our old buildings. The new buildings when completed will afford storage for about 300 tons of hay, 325 tons of silage, several carloads of grain, 144 tons of roots, and a large supply of absorbents and bedding for the stables. They will accommodate 100 head of cattle, 14 horses, 75 sheep and 80 hogs. They will provide convenient storage for vehicles and implements and contain a commodious tool-room and a repair shop. In connection with them, in one wing, we have accommodations for a dairy school, as well as for handling our large amount of milk. This wing is to contain a boiler-room, with coal and tool closets; a room for ice, which will contain over 300 tons; a room for the operation of heavy machinery (separators, butter-accumulators, etc.); a room for churns, butter-workers, etc.; a room for Cooley creamers, a large lecture-room and a laboratory for the examination of milk and its products. I sincerely hope it may be found possible to equip the barn with electric power and lights, and I believe that in its large and substantial boiler and engine rooms should be generated electricity to supply all of our college buildings.

The work upon the barns and dairy school is well advanced. The foundations will be completed by October 14, and much of the framing is already done. One wing of the barn is now ready for the steel roofing which it is to receive. It is expected that the ice can be stored in the new buildings this winter, that the lecture room will be ready for occupancy by January 1, and that the buildings will be entirely completed by May 15, 1894. The location of the new buildings, central as it is, will make the performance of farm work far less expensive than at present.

In conclusion, I desire to express my sincere appreciation of the hearty and efficient co-operation of all those who have been connected with me in the work of the past year. The future of the college farm appears bright; with the hearty support which from its importance it merits, the time will soon come when every field and crop shall teach important lessons. It is my aim to put to each such questions as appear to need an answer, and studiously and carefully to interpret the results for the benefit of students and the farming public alike.

W. P. Brooks,
Professor of Agriculture.

Experiment Department.

Bulletins during the year have been published on the following subjects: —

Report on the comparative tests of varieties of small fruits: Ninety-six varieties of strawberries, of which the following seemed to give most promise of value for home use or for market: Beder Wood, Belmont, Bubach No. 5, Edgar Queen, Haverland, Martha, Parker Earle, Parmenter's Seedling, Seedling No. 24 and Wolverton; twelve varieties of red and fifteen varieties of black-cap raspberries; thirteen varieties of blackberries; one hundred and fifteen varieties of grapes, of which the following were recommended for New England growth: Berckman's, Brighton, Concord, Delaware, Iona, Lindley (Rogers No. 9), Moore's Early, Winchell (Green Mountain) and Worden.

Report on the use of fungicides and insecticides for the grape, peach, plum, pear, apple, potato and black or Italian poplar.

Report on insects, containing brief histories of the canker-worm, the apple-tree tent-caterpillar, fall web-worm and the tussock moth, with directions for their destruction.

Of special interest was a series of experiments conducted by the meteorological division in electro-culture. The results obtained would seem to be in every particular identical with those recently published by Professor Chodat of Geneva. Of two lots of seeds planted under the same conditions of moisture, temperature and soil, those under the influence of electricity germinated earlier, and there was a marked difference at first in the superior vigor of their stems, leaves and roots. But in a short time the non-electrified plants seemed to overtake them, and the difference in foliage was not appreciable to the eye. The crops, however, differed materially; those subjected to the influence of electricity being larger, heavier and differing in form. The experiments conducted here, at Geneva and St. Petersburg would seem to bear out the conclusions that the use of electricity forwards germination, growth in length and increase of size and weight.

The Horticultural Division.

Comparison of New and Old Varieties of Fruits.

All the new varieties of fruits, both large and small, that are recommended as of value are obtained by purchase from the originator or introducer as soon as they are put on the market, or are received from the originator with restrictions as to dissemination. The former is preferred, in order that we may have the right to distribute without conditions such varieties as seem valuable among the fruit-growers of the State for further trial under different conditions of soil and exposure. Careful examination of all these varieties is made as to growth, freedom from disease, quality, etc., and records are made from time to time during the season, using the older varieties for comparison.

At present there are growing on the college grounds about —

100 varieties of apples.
40 varieties of pears
38 varieties of plums.
16 varieties of cherries.
20 varieties of peaches.
6 varieties of quinces.
130 varieties of grapes.
120 varieties of strawberries (excluding all the older sorts that have no marked characteristics that make them valuable for comparison).
15 varieties of currants.
12 varieties of gooseberries.

Few of the new varieties of the large fruits show marked improvement over the older standard sorts, although some very promising additions have been made.

It is hardly possible to report definitely as to the value of the above in the time the work has been in operation, but among the small fruits more positive results have been reached.

Grapes. — Among the grapes we would mention as especially valuable varieties the following: Winchell (or Green Mountain) — This is the earliest grape of good quality we have tested; it ripens with or a little before the Moore's Early and fully a week before the Concord and Delaware, and is much better in quality than either of the first two; the berry is medium in size, the bunch medium to large and greenish-yellow in color; the vine is, thus far, hardy, fairly vigorous and productive. Peabody — This variety has fruited two seasons in the vineyard here, and is one of the most promising black grapes in the collection; the berry is black, covered with an abundant bloom, of medium to large size; the bunch of large size and of good quality; the vine is vigorous, hardy and productive, and the foliage, of the *cordifolia* or pigeon-grape type, has proved thus far entirely free from mildew; this variety would not be classed as a sweet grape, but is vinous and the seeds separate easily from the pulp, which is not as acid as the Concord or Worden.

Blackberries and Black-cap Raspberries. — No new varieties of either of the above have been found that will supersede the old sorts.

Red Raspberries. — To the list of varieties for general planting, for home use and market we think should be added Thompson's Pride and Thompson's Early Prolific. Both varieties are very early, earlier than the Hansell, of equally good quality with that variety, more firm and produce a larger berry. They are perfectly hardy and fairly productive.

Strawberries. — The variety called the Marshall has attracted more attention than any other during the two seasons past. The plant is remarkable for its vigor, while the berry is of the largest size, of good form and the best quality. Should it prove as hardy, productive and free from disease as it now promises, the introduction of this variety will mark a new era in strawberry growing. No other of the new varieties shows such decided improvement over the old sorts.

List of Varieties of Large and Small Fruits.

For general purposes of market and home use, we would recommend the following, in their order of ripening: —

Apples. — Red Astrachan, Oldenburg, Haas, Gravenstein, Fall Pippin, Rhode Island Greening, Baldwin, Roxbury Russet.

Pears. — Giffard, Clapp, Margaret, Bartlett, Bosc, Sheldon, Seckel, Lawrence, Anjou, Dana's Hovey.

Peaches. — Amsden, Early Rivers, Mountain Rose, Crawford's Early, Oldmixon, Crosby, Crawford's Late, Stump.

Plums. — Bradshaw, McLaughlin, Lombard, Imperial Gage, German prune, Reine Claude de Hartive.

Quinces. — Orange, Rea's Mammoth.

Grapes. — Winchell (Green Mountain), Moore's Early, Worden, Concord, Delaware.

Blackberries. — Agawam, Snyder, Taylor's Prolific.

Black-cap Raspberries. — Souhegan, Carman, Hilborn, Ohio.

Red Raspberries. — Thompson's Pride, Thompson's Early Prolific, Hansell, Marlboro, Cuthbert.

Currants, — Versaillaise, Cherry, Fay's Prolific.

Strawberries. — Beder Wood, Bubach No. 5, Haverland, Sharpless, Beverly.

Spraying Apparatus.

The work of testing the various kinds of spraying apparatus has been continued, with the results that we find nothing that better answers the purpose for general work than the pumps and nozzles made by the large pump manufacturers in various parts of the country.

Fungicides and Insecticides combined.

Again the value of the use of combined fungicides and insecticides has been demonstrated in securing a fine crop of grapes, cherries, plums and apples, free from injury by insects or fungous growths.

THE ENTOMOLOGICAL DIVISION.

During the past season a series of experiments has been conducted with various insecticides on the gypsy moth and tent caterpillar, for the purpose of determining which insecticide would prove the most efficacious and also the least injurious to the leaves of the trees.

The insecticides used in these experiments were Paris green, Paris green and lime, arsenate of soda, arsenate of lead and Oriental Fertilizer.

Paris green gave results similar to those which had been obtained with it in previous years. The object in repeating experi-

ments with this insecticide was to verify those made on the gypsy moth for three years past. Strange as it may seem, gypsy caterpillars, when half grown or larger, are not destroyed by any proportion of Paris green in water that can be used on fruit trees without injury to the foliage.

Experiments with Paris green and lime have been made at some of the stations, and it was reported that this mixture permitted a larger proportion of Paris green to be used without injury to the foliage. This, however, did not prove true in the experiments made here, and they were also repeated with the same results in the field at Malden.

Arsenate of soda was tried in varying proportions, but invariably injured the foliage, except when used in such small proportions as not to kill the caterpillars on the trees.

The Oriental Fertilizer, a preparation for sale by a firm in Chicago, was tried, but, when used in the proportion recommended by the manufacturers, injured the foliage, and when used in smaller proportions did not destroy the caterpillars.

The experiments with arsenate of lead proved very satisfactory in some respects, for it did not injure even the most delicate foliage, however large a proportion was used. In one case 24 pounds to 150 gallons of water were used without injury to the leaves. A complete account will be given later in a bulletin.

The study of the cranberry insects has been continued, and a number of insects which have not previously been reported as injurious to the cranberry have been found feeding on the vines.

The biological collection has been largely increased, and not only makes a fine display, but also proves exceedingly useful in the work at the insectary. This collection consists of the eggs and inflated caterpillars of all sizes, as well as the pupæ and moths of many of our common species, placed in a row in such a manner as to show at a glance the life history from the egg to the adult. The collection now fills five large trays.

The card catalogue is now far advanced, and proves exceedingly useful as a work of reference.

The correspondence continues to increase, and occupies much time, proving in many cases very irksome.

A new insect has appeared in the plant-house and on the grounds, on various species of plants, and may become a troublesome pest. This is an imported insect, a native of China, a member of the order Hemiptera, or true bugs, and of the family Coccidæ, or bark-lice, and has been named *Orthezia insignis* Doug. My attention was first called to it by Mrs. Goodell, who found it

on a plant received from the plant-house, where it appears to be a common resident. A more complete account of the history and habits of this insect will be given at another time.

Meteorological Division.

Much has been done toward perfecting plans and accomplishing the work decided upon in our last report. From the beginning the desire has been to make this division of a practical and useful nature, and the growing interest which the public has manifested in the observatory is most gratifying, and should be an additional incentive toward making the work one of general importance.

A complete set of telegraph instruments has been placed in the observatory, and a loop now connects the latter with the main line at the centre of the town. This loop was placed on a line of electric-light poles between the town and college, belonging to the Amherst Gas Company, the latter having kindly granted this privilege, thus saving considerable expense to the division, and the observatory now is in close touch with the Government Weather Service.

The forecasts for twenty-four hours in advance are received daily about 10.30 in the morning, and are automatically recorded in the tower. Signals are displayed from an iron pole, 37 feet in height, placed on top of the tower, and can be seen over a considerable extent of country. Arrangements have also been completed whereby frost warnings may be telegraphed to the station during the period of early and late frosts. The signal flags were furnished by the Weather Bureau, and all forecasts and frost warnings are sent at Government expense.

In addition to the large amount of routine work connected with the observatory, experiments in electro-culture have been carried forward. Two years since, this line of investigation was undertaken, but owing to adverse circumstances the work was delayed till the present year. At considerable expense a plot of ground has been furnished with wires and apparatus for controlling and measuring the electric current, and the effect of electricity upon various kinds of vegetables has been carefully watched and recorded. The results of the experiment will appear later in bulletin form, as it is too early to give in this report a full account of the observations.

The Agricultural Division.

The experimental work of the past season has been more extensive than in any previous year; but, owing to the early date at

which this report is made, it is impossible to present many results in a satisfactory manner. Our corn, soya bean and millet crops are not yet harvested; our silo, though filled, cannot be opened; analytical work and moisture tests are not completed, and data have not been worked up. The incomplete nature of this report is therefore unavoidable.

Soil tests have occupied a large share of attention. These have been confined to land in grass, with the exception of one acre upon our own grounds, which was sown with oats. Four tests have been conducted with grass upon the grounds of selected farmers in different parts of the State and one upon our own grounds. In all, the difference in the character of the growth produced by the different fertilizers and combinations of fertilizers has been a most marked feature. Wherever potash has been applied, whether alone or in combination with other elements, the growth of the clovers has been strong; and to a less degree the presence of phosphoric acid promotes the growth of the same plants, while the nitrate increases the yield of the grasses proper. Only upon the plats receiving potash and those which received manure has there been any considerable growth of rowen. These results which we have obtained indicate that the conditions controlling the growth of clover here are the same as those in other countries, where it has long been known that clover follows potash. The farmer who would raise more of this invaluable fodder should make sure that his land is well stored with potash and phosphates. This plant can draw much of its nitrogen from the air. An interesting result of our experiments with fertilizers upon grass land is the demonstration afforded of the remarkable capacity of soils to hold even soluble forms of potash and phosphoric acid. These do not appear to be diffused laterally to any considerable extent, remaining just where they are placed. The line between clover and "no clover" on adjoining plats, one of which had and the other had not received any potash, has been as true as it could be drawn. The clover comes up to the line and there stops short.

The soil test with oats was quite unsatisfactory on account of the lodging of the crop upon a part of the plats. Throughout the early stages of growth the phosphoric acid appeared to be the controlling element; but upon threshing, it was found that the plats which had received potash gave the largest yields. The results, however, were quite indecisive on account of the injury from lodging, due to heavy showers and wind.

Manure alone versus Manure and Potash for Corn has been under trial for the third year upon the same land. The applica-

tion where manure alone was used was at the rate of 6 cords per acre. Where the manure and potash were used, we applied 4 cords of the former and 125 pounds of the muriate of potash. The crop has not been husked, but appears to be very even, with the probabilities in favor of the larger yield where manure alone was applied. The application of 6 cords of manure costs $30. Four cords of manure and the 125 pounds of muriate of potash cost $22.65. The latter application will yield the greater profit.

Special Corn Fertilizer has been under comparison with a home mixture containing more potash. The crop is in the stack and too nearly even to warrant an assumption of superiority for either.

Drill and Hill Culture of corn have been compared upon one acre, with the advantage clearly with the drill, though figures cannot now be given. The seed germinated more quickly and better, and the crop was much more clearly vigorous from the start.

The Effect of sowing White Mustard in the standing corn early in August has been under study upon one acre. The present is the second year of this trial; but the results are not yet striking. In a series of years it is confidently believed the effect will prove beneficial, as the growing mustard conserves the nitrogen of the soil, and it is sufficiently hardy to grow until about the middle of November.

An Experiment with Scarlet Clover used in a similar way has been begun, but no results can be obtained before another year.

The two experiments for the comparison of the muriate with the sulphate of potash described in the last annual report have been repeated this year upon the same land. Equal amounts of materials furnishing nitrogen and phosphoric acid are used upon all the plats, and the same number of pounds of actual potash is applied to each; but upon two of the $4\frac{1}{6}$-acre plats the muriate is the compound of potash used; on the other two the sulphate is used. On one each of both the muriate and sulphate plats the fertilizers were all spread broadcast and harrowed in; on the other plat of each they were all put in the drill.

This year, as last, the larger yield is produced by the sulphate of potash; but the difference is less than last year. Last year the quality of the potatoes raised on the sulphate was much better than that of those grown on the muriate. This year the most careful tests of a number of different parties fail to detect any appreciable difference. Both are of a very superior quality. In appearance the advantage is with the potatoes raised on the muriate of potash; they average larger and there are fewer very small ones. The yields per acre were as follows: —

Sulphate of Potash.

Broadcast: Merchantable tubers, 290.4 bushels; small tubers, 26.4 bushels.

Drill: Merchantable tubers, 344.4 bushels; small tubers, 15 bushels.

Muriate of Potash.

Broadcast: Merchantable tubers, 285.6 bushels; small tubers, 15 bushels.

Drill: Merchantable tubers, 325.8 bushels; small tubers, 21 bushels.

This year, as last, the advantage lies with drill application, and the differences are even greater than last year. The past season has been much drier than last, and this, I think, explains the fact that the quality of the potatoes grown on the muriate is this year equal to that of those grown on the sulphate, while last year it was much inferior. It does not seem best to theorize, however. This experiment must be repeated upon both the same and different soils.

The millets, *Panicum crus galli* and *miliaceum*, have had a more extended trial this season as crops for green fodder and ensilage. The first proves much the more valuable of the two. It grows quickly and gives yields of 10 to 14 tons per acre. That ensilaged last year made excellent silage, a sample of which was sent to the laboratory for analysis. The results are not yet received. This year both these millets were sown June 12, after a crop of rye had been removed. They were put into the silo September 18 and 19, in alternate layers with soya beans.

We have cultivated in small amounts some twenty varieties of soya and other Japanese beans the past season, but these are not yet all harvested. It is thought that the early white and the medium green and black varieties first cultivated here will prove as valuable as any. The first gives a fine yield of seed. The others have ripened perfectly for the last five years, but are a little late for this section. They appear to be valuable varieties for fodder or for ensilage.

The appearance of tubercles which are known to be connected with the assimilation of atmospheric nitrogen upon the roots of some varieties under cultivation last year and not upon others led us to undertake investigations to determine the causes of this difference. A crop with these tubercles upon its roots can take free nitrogen from the air, but without them it is powerless to do so; hence the interest of the inquiry. A large number of plats in different localities, a number of pots of plants and several varieties of beans have been under cultivation for the purposes of this study, but our work is not sufficiently advanced to enable me to report.

The possibility of raising good seed of Canada and other field peas and of spring vetches has been tested with favorable results for the peas and unfavorable for the vetches. The peas can be raised for much less than the usual market price of such seed.

The experiment for the comparison of fertilizers with manures as top-dressing for grass lands has been continued, this being the fourth year. There have been seven half-acre plats and three quarter-acre plats. Three plats have received an application in early spring of a mixture of bone meal, muriate of potash and nitrate of soda, in amounts varying on the different plats as follows: Bone meal, 300 to 400 pounds; muriate of potash, 160 pounds in all cases, and nitrate of soda, 150 to 200 pounds. Four plats were top-dressed with good manure at the rate of 3 cords per acre. Three plats received nothing and have received nothing for four years. The average increases per acre over the nothing plats, which served as a basis of comparison, were as follows: —

For the fertilizer: First cutting, 2,115 pounds; rowen, 334 pounds.
For the manure: First cutting, 1,650 pounds; rowen, 605 pounds.

The fertilizers applied cost from $12 to $13 per acre, and gave a total increase of 2,449 pounds of hay. The manure, if purchased and applied, would have cost $18 per acre, and it produced a total increase of 2,255 pounds of hay. It should be remembered in drawing conclusions that these plats have respectively been receiving manure and fertilizer for four years. This year, as in previous ones, the fertilizers have given the more profitable increase in the crop.

We have established a grass garden which contains all the leading varieties of grasses and clovers. We have made extensive collections of both fresh and salt marsh grasses and sedges; and also a large collection of the seeds of weeds commonly found in mowings, with a view to future experiments.

During the early spring an experiment was begun with eight cows, divided into two lots of four each, to test the relative value of cotton-seed meal and soya-bean meal as food in a well-balanced ration for milch cows. The experiment continued six weeks in two periods of three weeks each, the yield of the last two weeks of each period only being counted. Omitting all details, the leading results are the following: —

1. The cows on the soya-bean meal gave rather the most milk.
2. The cotton-seed meal gave more spaces of cream as read in the Cooley can.
3. This cream, when cotton-seed meal was fed, was much more

dilute than when soya-bean meal was fed, the line of demarkation being much less perfectly defined.

4. Chemical analyses showed the cream from the cows fed on soya-bean meal to be the richer, the figures being: Soya-bean cream, butter fat, 17.83 per cent; cotton-seed meal cream, butter fat, 17.09 per cent.

5. To make one pound of butter required on the average 7.27 spaces of cotton-seed cream and 6.27 spaces soya-bean cream.

6. The cotton-seed butter was of firmer texture than the other, but was, by the verdict of three families working independently and without knowledge of the nature of the difference between the samples, decidedly inferior to that made from the soya-bean cream. The latter was of a higher color and much more agreeable texture and flavor. The cotton-seed butter had a greasy feeling in the mouth, while the other was of agreeable texture.

7. A larger percentage of the total fat in the milk was recovered in the cream from the cows fed on cotton-seed meal than in the cream from those fed on bean meal.

Below are given tables which show in detail the leading results of the experiment: —

First Lot of Cows.

PERIOD.	Total Amount of Food Consumed.					Total Refuse from Mangers.	Average Weight of Cows.	Yield.	
	Hay.	Silage.	Bran.	Cotton-seed Meal.	Soya Bean Meal.			Milk.	Cream.
	Lbs. Oz.	Lbs. Oz.	Lbs. Oz.	Lbs. Oz	Lbs. Oz.	Lbs. Oz.	Lbs.	Lbs. Oz.	Spaces.
First, . .	540 8	1,539 –	323 12	203 –	– –	82 11½	949.75	1,145 13	344.75
Second, .	541 12	1,506 –	323 12	– –	215 4	71 13½	960.50	1,166 3	330

Second Lot of Cows.

	Lbs. Oz.	Lbs. Oz.	Lbs. Oz.	Lbs. Oz.	Lbs. Oz.	Lbs. Oz.	Lbs.	Lbs. Oz.	Spaces.
First, . .	554 12	1,539 12	320 4	– –	211 12	97 12½	935	1,018 4	299.25
Second, .	553 –	1,484 –	292 4	211 12	– –	134 ½	943.25	1,014 8	312.5

It would appear from this experiment that the soya-bean meal is superior to cotton-seed meal as a food either for milk or butter production. If further work establishes this conclusion, it lies within the power of Massachusetts farmers to raise the concentrated nitrogeneous food needed for their animals.

During the past season this department has sold to farmers in this State, at prices barely sufficient to cover cost, a considerable quantity of the seeds of the three millets, *italicum*, *crus galli* and

miliaceum and of soya beans of the early white variety. We shall solicit reports on these crops for future publication of the farmers' verdict.

Annual Statement of the Hatch Fund,

For the Year Ending June 30, 1893,

By George F. Mills, Treasurer *pro tempore.*

Cash received from the United States,		$15,000 00
agricultural department,		511 79
M. A. C. farm,		3 74
expense account,		10 66
chemical department,		14 17
M. A. C. labor fund,		63 40
		$15,603 76
Cash paid, salaries,	$4,546 98	
library,	84 13	
labor,	4,969 29	
freight and express,	108 38	
printing,	1,189 61	
incidentals,	1,219 94	
supplies,	2,364 48	
chemical apparatus,	60 00	
postage,	109 75	
travelling expenses,	116 70	
barn,	750 00	
furniture,	84 50	
		$15,603 76

Amherst, Mass., Sept. 23, 1893.

I, the undersigned, duly appointed Auditor, do hereby certify that I have examined the books and accounts of the Hatch Experiment Station of the Mass. Agricultural College for the fiscal year ending June 30, 1893; that I have found the books well kept and the accounts correctly classified as above, and that the receipts for the time named are shown to be $15,603.76 and the corresponding disbursements $15,603.76. All of the proper vouchers are on file and have been by me examined and found to be correct, there being no balance to be accounted for in the fiscal year ending June 30, 1893.

CHARLES A. GLEASON, *Auditor.*

I hereby certify that the foregoing is a true copy from the books of account of the Hatch Experiment Station of the Massachusetts Agricultural College. George F. Mills, *Treasurer pro tem.*

I hereby certify that George F. Mills is the treasurer *pro tem.* of the Massachusetts Agricultural College, and that the above is his signature.

[Seal.] Henry H. Goodell,

President Massachusetts Agricultural College.

Gifts.

From State Experiment Station, collection of concentrated food-stuffs.

William Deering & Co. of Chicago, Giant mower.

William I. Marshall of Chicago, Ruggles rotary cultivator.

Gilbride & Gray of Boston, old wooden plow.

German Kali Works of New York, collection potash minerals.

Peter Henderson & Co. of New York, collection grass and clover seeds.

Chilian Nitrate Combination, two bags (200 pounds) Chilian 95 per cent. nitrate of soda.

Charles L. Flint (M. A. C., '81) of Boston, crayon portrait of President Charles Louis Flint.

H. Heaton, Esq., of Amherst, facsimile of Shakespeare's will.

Luther W. Smith (M. A. C., '93) of Ashfield, picture of Tennyson.

C. D. Warner (M. A. C., '81) of Amherst, mathematical prize for 1894.

The Western Alumni Association, rhetorical prizes for 1894.

William B. Court of Montreal, sixty-one volumes standard fiction.

John R. Perry (M. A. C., '93) of Boston, picture of foot-ball team, 1892.

Charles A. Goodrich (M. A. C., '93) of Hartford, Ct., picture of base-ball team, 1893.

Aggie Life Board, picture of Aggie Life Board, 1892–93.

Agricultural College Base-Ball Team, picture of team, 1892.

Agricultural College Glee Club, picture of club, 1891–92.

Agricultural College Orchestra, picture of orchestra, 1892–93.

William Trelease of St. Louis, Mo., "Further Studies of Yuccas and Their Pollination."

Miss M. A. Brown of Southampton, England, "Life and Reminiscences of John Rogers."

Massachusetts Society for Promoting Agriculture, "Law of the Roadside: How to Protect our Landscape."

Hon. George F. Hoar of Washington, D. C., "Compendium of Eleventh Census"; "Revised Statutes of the United States"; "Supplement to Revised Statutes of the United States."

From Lieut. Walter M. Dickinson of Amherst, "Freshman and Senior."

William H. Whitmore of Boston, "Report of Record Commissioners of City of Boston, 1769–75."

Charles S. Plumb (M. A. C., '82) of La Fayette, Ind., "How Science is Helping the Farmer."

Hon. Edmund H. Bennet of Boston, "Massachusetts Farm Law."

Miss Eleanor A. Ormerod of Spring Grove, England, "Injurious Insects and Common Farm Pests."

L. B. Townsend of Ionia, Mich., "American Rambouillet Record."

Ginn & Co. of Boston, "Answer to the Question, What is Poetry?"

Thomas B. Wales of Boston, "Proceedings of the Holstein-Friesian Association of America."

B. M. Lelong of Sacramento, Cal., "Report on the Importation of Parasites and Predaceous Insects, by the State Board of Horticulture."

John Speir of Newton, Glasgow, Scotland, "Field Cultivation of the Potato"; "Mechanical Milking Apparatus"; "Depth at which Grass Seed should be sown."

Carpenter & Morehouse of Amherst, nine bound volumes of "Amherst Record."

Henry Wallace of Des Moines, Iowa, "Clover Culture."

William H. Bowker (M. A. C., '71) of Boston, "The Harvest of the Sea."

David P. Penhallow (M. A. C., '73) of Montreal, "Trees and Shrubs of Northern Japan."

H. Holt & Co. of New York, "Representative English Literature."

Albert A. Pope of Boston, "Catalogue of Books, etc., on the Construction and Maintenance of Roads, and Road-making as a Branch of Instruction."

Joseph B. Lindsey (M. A. C., '83) of Amherst, "Untersuchung über Holz u. Holz-Sulfit Flüssigkeit"; "Agricultural Experiment Stations of Germany"; "Composition of Wood."

Massachusetts Woman Suffrage Association, two pamphlets on woman suffrage.

Edgar H. Libby (M. A. C., '74) of New York, "American Gardening" for 1893.

S. W. Nickerson of Boston, "The Financial Independence of the United States."

From W. Atlee Burpee & Co. of Philadelphia, Pa., "Manures: How to Make and How to Use Them."

Meadville Theological School, Gladwin's "Tools and the Man."

George B. Knapp of Auburndale, three volumes "History of North American Birds."

Sir John B. Lawes of Rothamsted, England, "Allotments and Small Holdings."

Arthur A. Brigham (M. A. C., '78) of Sapporo, Japan, "Our Native Birds of Song and Beauty."

Topographical Commission, "Atlas of Massachusetts, 1884–90."

Royal Society of Canada, tenth volume of "Transactions."

Also the following papers and periodicals from the publishers: "The Massachusetts Ploughman," "The American Cultivator," "The New England Farmer," "The American Veterinary Review," "The American Garden," "The Poultry Monthly," "The Mirror and Farmer," "The American Grange Bulletin," "The Farm and Home," "The Home Farm," "The Ohio Practical Farmer," "The Orange Judd Farmer," "The New England Homestead," "The Swine Breeder's Journal," "Louisiana Planter."

The college has been well represented in several departments at the World's Fair. In the forestry building, the timber and trimmings for the Massachusetts Bay window were furnished by Mr. John W. Howland under the supervision of the president; and the sections of logs, forty-seven in number, each $2\frac{1}{2}$ feet in length by 12 inches in diameter, representing the trees of the State, were procured by students under the direction of Professor Maynard. In addition to the above, the following exhibit was made: —

A map of the college grounds, locating buildings and roads.

Models of fruit and vegetables illustrating progress in horticulture.

Model of the squash used in determining the expansive power of the growing cell, together with the apparatus employed.

Apparatus used in determining the force and flow of sap.

Endless roller chart prepared by Professor Maynard and used in botanical lecture room.

Clastic model of the horse.

Photographs of buildings and lecture rooms.

Photographs of different college organizations.

Bound volumes of college and station literature.

Thirteen boxes soils.

Exhibit of plants and seeds (Japanese and native).

Boxes containing prepared specimens of the gypsy moth in all stages of development.

Photographs illustrating ravages of the same.

In addition to the catalogue and customary reports from the treasurer and military department, I have the honor to append a paper translated by Dr. Edwin W. Allen, on a subject of practical importance to every farmer, "On the True Value of Green Manuring," by Prof. Julius Kühn, director of the Agricultural Institute at Halle, Germany.

Respectfully submitted, by order of the trustees,

HENRY H. GOODELL,

President.

AMHERST, October, 1893.

TREASURER'S REPORT.

George F. Mills, *Treasurer of Massachusetts Agricultural College, for Nine Months, Jan. 1, 1893, to Oct. 1, 1893.*

	Received.	Paid.
Cash on hand,	$5,042 32	–
Term bill,	3,694 96	$848 86
Botanical department,	4,188 12	6,042 46
Farm,	4,261 06	9,874 98
Expense,	759 81	5,152 23
Laboratory,	820 75	221 88
Salary,	187 50	4,274 73
Endowment fund,	5,263 33	–
State scholarship fund,	7,500 00	–
Hills fund,	348 92	225 70
Grinnell prize fund,	37 50	50 00
Whiting Street fund,	20 00	25 00
Mary Robinson fund,	35 08	50 00
Gassett scholarship fund,	–	–
Burnham emergency fund,	124 30	15 00
Labor fund,	2,500 00	2,783 30
Extra instruction,	–	308 00
Insurance,	–	1,474 48
Advertising,	–	20 00
Columbian Exposition,	51 60	51 60
Investment, N. Y. C. & H. R. R.R. stock,	–	50 00
Special appropriation, dam,	–	1,726 42
Special appropriation, fertilizer botanical department,	–	637 56
Special appropriation, cold grapery,	–	204 42
Special appropriation, museum cases,	–	457 16
Special appropriation, heating Hatch barn,	–	200 00
Cash on hand, Oct. 1, 1893,	–	141 47
	$34,835 25	$34,835 25

This is to certify that I have this day examined the accounts of George F. Mills, treasurer *pro tem.* of the Massachusetts Agricultural College, from Jan. 1, 1893, to Oct. 1, 1893, and find the same correct, properly kept and vouched for, the balance in the treasury being one hundred and forty-one and 47-100 dollars ($141.47), which sum is shown to be in the bank.

CHARLES A. GLEASON, *Auditor.*

Amherst, Oct. 4, 1893.

Cash Balance, as shown by the Treasurer's Statement, belongs to the Following Accounts:

Gassett scholarship fund,	$44 70
Burnham emergency fund,	96 77
	$141 47

Bills Receivable, Oct. 1, 1893.

Farm,	$5 19
Term bill,	1,901 02
Laboratory,	150 07
Botanical,	970 39
Labor fund,	583 16
	$3,609 83

Bills Payable, Oct. 1, 1893.

Hills fund,	$319 53
Grinnell prize fund,	20 00
Whiting Street fund,	49 91
Mary Robinson fund,	161 40
Burnham emergency fund,	12 53
Farm,	390 42
Term bill,	518 85
Botanical,	720 83
Expense,	1,769 94
	$3,963 41

Inventory — real estate.

Land.

	Cost.	
College farm,	$37,000 00	
Pelham quarry,	500 00	
Bangs property,	2,525 00	
		$40,025 00

Buildings.

	Cost.	
Laboratory,	$10,360 00	
Botanic museum,	5,180 00	
Botanic barn,	1,500 00	
Durfee plant-house and fixtures,	12,000 00	
Small plant-house and fixtures, with vegetable cellar and cold grapery,	4,700 00	
Tool-house,	2,000 00	
Amounts carried forward,	$35,740 00	$40,025 00

Amounts brought forward,	$35,740 00	$40,025 00
North college,	36,000 00	
Boarding-house,	8,000 00	
South dormitory,	37,000 00	
Graves house and barn,	8,000 00	
Farmhouse,	4,000 00	
Farm barns and shed,	14,500 00	
Stone chapel,	31,000 00	
Drill hall,	6,500 00	
President's house,	11,500 00	
Four dwelling-houses and shed, purchased with farm,	10,000 00	
		202,240 00
		$242,265 00

PERSONAL PROPERTY.

Botanical department,	$11,853 00
Farm,	22,356 00
Laboratory,	3,469 00
Natural history collection,	4,758 79
Veterinary department,	1,443 39
Agricultural department,	3,008 00
Physics,	5,471 28
Library,	14,200 00
Fire apparatus,	500 00
Boarding-house,	200 00
Books and furniture in treasurer's office,	523 65
	$67,783 11

Summary Statement.

Assets.

Total value real estate, per inventory,	$242,265 00
Total value personal property, per inventory,	67,783 11
Bills receivable, per inventory,	3,609 83
	$313,657 94

Liabilities.

Bills payable, per inventory,	3,963 41
	$309,694 53

Maintenance Funds.

Technical education fund, United States grant,	$219,000 00
Technical education fund, State grant,	141,575 35
	$360,575 35

By law two-thirds of the income from these funds is paid to the treasurer of the college, and one-third to the Institute of Technology. Amount received by college treasurer, January 1 to October 1, ...	$5,263 33
Hills fund, the gift of Messrs L. M. and H. F. Hills of Amherst, now amounts to $8,542. By conditions of the gift the income is to be used for the maintenance of a botanic garden. Income from January 1 to October 1, . . .	348 92

SCHOLARSHIP FUNDS.

State scholarship fund, $10,000. This sum was appropriated by the Legislature in 1886, and is paid in quarterly payments to the college treasurer. Amount received, Jan. 1 to Oct. 1, 1893, ...	5,000 00
Annual State appropriation of $10,000. This sum was appropriated by the Legislature of 1889 for four years, and continued by the Legislature of 1892 for another four years, for the endowment of additional chairs of instruction and for general expense. Five thousand dollars of this sum was set apart as a labor fund, to provide for payment for labor performed by needy and worthy students.	
Annual State scholarship. Appropriation received January 1 to October 1, ...	2,500 00
Labor fund, received January 1 to October 1, ...	2,500 00
Mary Robinson fund amounts to $858. This fund was given without conditions. The income from it has been appropriated for scholarships to worthy and needy students. Income from January 1 to October 1, ...	35 08
Gassett scholarship fund, $1,000. This sum was given by the Hon. Henry Gassett as a scholarship fund.	

PRIZE FUNDS.

Grinnell prize fund, $1,000. This fund is the gift of ex-Governor William Claflin, and is called Grinnell fund in honor of his friend. The income is appropriated for two prizes to be given to the two members of the graduating class who pass the best examinations in agriculture. Income from January 1 to October 1, ...	37 50

MISCELLANEOUS FUNDS.

Whiting Street fund, $1,000. This fund is a bequest without conditions. To it was added $260 by vote of the trustees in January, 1887, the interest accrued on the bequest. Amount of fund, Oct. 1, 1893, $1,260. Income from Jan. 1 to Oct. 1, 1893, ...	20 00
Amount carried forward, ...	$15,704 83

Amount brought forward,	$15,704 83
Library fund, for use of the library, Oct. 1, 1893, $8,490.80. Deposited in Amherst Savings Bank.	
Burnham emergency fund, $5,000. This fund is a bequest of Mr. T. O. H. P. Burnham, late of Boston. It was made without conditions. The trustees of the college have voted that the fund be kept intact, and that the income from it be used by the trustees for such purposes as they believe to be for the best interests of the college. Income from January 1 to October 1,	124 30
	$15,829 13

To this sum must be added amount of tuition and room rent, and receipts from sales of farm and botanic gardens. These amounts can be learned from treasurer's statement, tuition and room rent being included in term bill account.

Report of Morrill Fund, Oct. 1, 1893.

Receipts.

1892.		
April 9.	Cash received of State treasurer,	$10,000 00
June 25.	Cash received of State treasurer,	22,000 00
Sept. 15.	Cash received of State treasurer,	12,000 00
Oct. 14.	Cash received of W. B. Clarke & Co.,	2 00
1893.		
Aug. 5.	Cash received of State treasurer,	12,666 66
	Total receipts,	$56,668 66

Expenditures, April 1, 1892, to Oct. 1, 1893.

Agriculture.

Instruction,	$2,500 00		
Apparatus,	4,199 68		
Machinery,	276 50		
Text-books and reference books,	4,067 10		
Stock and material,	2,618 50		
		$13,661 78	

English Language.

Instruction,	$2,500 00		
Apparatus,	225 20		
Machinery,	–		
Text-books and reference books,	1,208 23		
Stock and material,	387 75		
		4,321 18	
Amounts carried forward,		$17,982 96	$56,668 66

Amounts brought forward, . . .		$17,982 96	$56,668 66
Mathematical Science.			
Instruction, ...	–		
Apparatus, ...	–		
Machinery, ...	–		
Text-books and reference books, .	$67 16		
Stock and material, ...		67 16	
Physical Science.			
Instruction, ...	$2,500 00		
Apparatus, ...	5,533 45		
Machinery, ...	–		
Text-books and reference books, .	726 54		
Stock and material, ...	265 28		
		9,025 27	
Natural Science.			
Instruction, ...	$7,500 00		
Apparatus, ...	3,403 66		
Machinery, ...	–		
Text-books and reference books, .	5,212 40		
Stock and material, ...	13 80		
		16,129 86	
Economic Science.			
Instruction, ...	–		
Apparatus, ...	–		
Machinery, ...	–		
Text-books and reference books, .	$640 89		
		640 89	
Mechanic Arts.			
Instruction, ...	–		
Apparatus, ...	$75 60		
Machinery, ...	–		
Text-books and reference books, .	–		
Stock and material, ...	–		
		75 60	
Cash on hand, Oct. 1, 1893, ...		12,746 92	
		$56,668 66	$56,668 66

REPORT OF THE PRESIDENT OF THE MASSACHUSETTS AGRICULTURAL COLLEGE TO THE SECRETARY OF AGRICULTURE AND THE SECRETARY OF THE INTERIOR, AS REQUIRED BY ACT OF CONGRESS OF AUGUST 30, 1890, IN AID OF COLLEGES OF AGRICULTURE AND THE MECHANIC ARTS.

I. *Condition and Progress of the Institution, Year ended June 30, 1893.*

The Massachusetts Agricultural College has never been in a more prosperous condition than during the year ending June 30, 1893. There was a total attendance of 193, with increasing numbers of resident graduates. Large additions have been made to the library and to the equipment in all departments, particularly in those of agriculture, botany, zoölogy, chemistry and electricity. Five new instructors, assistants in the chairs of agriculture, mathematics, botany, English and chemistry, have been added to the faculty, and the general course of study has been greatly modified. The studies of the senior year have been made elective, with choice of courses in electricity, forestry, cryptogamic botany, German, chemistry, entomology, mathematics, veterinary and social science. A short course of two years has been established, and a graduate course leading to the degree of M.S.

II. *Receipts for and during the Year ended June 30, 1893.*

1. State aid: (*a*) Income from endowment,	$3,808 62
(*b*) Appropriation for current expenses,	10,000 00
(*c*) Appropriations for building or other special purposes,	8,000 00
2. Federal aid: (*a*) Income from land grant, act of July 2, 1862,	7,333 95
(*b*) For experiment stations, act of March 2, 1887,	10,000 00
(*c*) Additional endowment, act of August 30, 1890,	12,000 00
3. Fees and all other sources,	750 00
Total receipts,	$51,892 57

III. *Expenditures for and during the Year ended June 30, 1893.*

1. College of agriculture and mechanic arts,	$41,892 57
2. Experiment station,	10,000 00
Total expenditures,	$51,892 57

IV. *Property and Equipment, Year ended June 30, 1893.*

Agricultural department —	
Value of buildings,	$200,540 00
Of other equipment,	54,211 73
Total number of acres,	384
Acres under cultivation,	244
Acres used for experiments,	58
Value of farm lands,	$10,025 00

V. *Faculty during the Year ended June 30, 1893.*

	Male.	Female.
1. College of Agriculture and Mechanic Arts: Collegiate and special classes,	12	–
2. Number of staff of Experiment Station,	9	3
Total, counting none twice,	21	3

VI. *Students during the Year ended June 30, 1893.*

	Male.	Female.
1. College of Agriculture and Mechanic Arts: Collegiate and special classes,	173	1
2. Graduate courses,	19	–
Total, counting none twice,	192	1

VII. *Library, Year ended June 30, 1893.*

1. Number of bound volumes, June 30, 1892,	*11,640
2. Bound volumes added during year ended June 30, 1893,	*2,400
Total bound volumes,	14,040

* Pamphlets, none.

MILITARY DEPARTMENT.

AMHERST, MASS., Sept. 30, 1893.

To President H. H. GOODELL.

SIR: — I have the honor to submit the following report, pertaining to the military department of the college, for the year ending Sept. 30, 1893: —

Since my last report, dated Dec. 31, 1892, a new floor has been laid in the drill hall, where it was much needed. For this purpose the State Legislature appropriated $500 at its last session. The floor is of North Carolina pine, riff sawed, and has added very much to the appearance of the hall. I would heartily recommend that as soon as practicable a gallery be placed across the south end of the hall, there now being no place for visitors except on the floor, where they are able to see very little and are also frequently in the way during drill.

Word has been received from the War Department that the college will soon be supplied with two 3.2-inch breech-loading guns, to replace the obsolete 12-pound Napoleons now in use. These guns will be of great practical value to the college, as the cadets can then be drilled in the use of breech-loading field guns, which are now the only ones used by the artillery for field service.

Application has also been made for twenty more Springfield cadet rifles; this was made necessary by the increase in the number of students at the commencement of the present college year.

The following is a list of the United States Government property now on hand: —

2 light 12-pound bronze guns and implements.
2 8-inch mortars, with implements.
2 gun carriages.
2 gun caissons.
2 mortar beds.
2 mortar platforms.
127 Springfield cadet rifles.
125 infantry accoutrements, sets.
31 headless shell extractors.
200 blank cartridges for field guns
10,000 metallic ball cartridges.
1,600 metallic blank cartridges.
600 friction primers.
4,000 pasters, white and black.
125 targets, A and B.

THEORETICAL AND PRACTICAL INSTRUCTION.

Theoretical — The students of the senior class are required to attend, one hour each week during the fall, winter and spring terms, theoretical instruction in the art and science of war. During the past year this consisted of recitations in the Infantry Drill Regulations, recitations in Wheeler's Art and Science of War, and a course of lectures on the following subjects: Armies, their composition, etc.; army administration, military law and explosives.

Owing to the limited time placed at my disposal, it is my intention during the present year to use only the Infantry Drill Regulations as a text-book, and give all other instruction by lecture. I shall thus be enabled, in addition to the subjects discussed during the past year, to take up the subjects of fortifications, both permanent and temporary, advanced and rear guards, outposts, patrols, etc.; also campaigns.

The freshman class receive theoretical instruction for one hour each week during the fall term; this time is devoted to the study of the Infantry Drill Regulations. It is desirable, after the new breech-loading field guns are obtained, that the sophomore class should receive theoretical instruction in the Artillery Drill Regulations.

Practical. — For practical instruction during the past year, the battalion was organized with four companies; this instruction was in the "school of the soldier," "school of the company," "school of the battalion" and in "extended-order drill." During the winter term the junior class was thoroughly instructed in the "sabre drill," and the sophomore class in "bayonet exercise." Also, during the winter term, both the sophomore and freshman classes were drilled for one hour each week in the "setting-up exercises." During the fall term, instruction was given the sophomore class in artillery, and details made up from the battalion were sent each drill day, when the weather permitted, to the target range for instruction in target practice. The total number of shots fired at this practice was 1,945, the average number of shots per student being 19+; the arm used was the Springfield cadet rifle. The spring term was devoted almost entirely to battalion drills and ceremonies.

All students of the college, except those excused for some physical disability, are required to attend three drills each week, each drill being for one hour.

The following three members of the last graduating class were reported by me to the Adjutant-General of the Army as

having shown the greatest proficiency in the art and science of war: —

GEORGE F. CURLEY,	Upton, Mass.
ALPHONSO E. MELENDY,	Sterling, Mass.
CHARLES A. GOODRICH,	Hartford, Conn.

This fall the battalion has again been organized with four companies, as follows: —

Commandant: — Lieut. W. M. DICKINSON, Seventeenth Infantry, United States Army.

Commissioned Staff: — Cadet First Lieutenant and Adjutant, H. P. SMEAD; Cadet First Lieutenant and Quartermaster, L. H. BACON; Cadet First Lieutenant and Fire Marshal, C. L. BROWN.

Non-Commissioned Staff: — Cadet Sergeant-Major, E. H. CLARK; Cadet Quartermaster-Sergeant, T. P. FOLEY.

Color Guard: — Cadet Color Sergeant, H. B. READ; Cadet Color Corporal, G. A. BILLINGS; Cadet Color Corporal, W. L BEMIS.

Band: — Cadet First Lieutenant and Band Leader, J. H. PUTNAM; Cadet Drum-Major, P. E. DAVIS; Cadet Band Sergeant, W. C. BROWN.

Companies.

Cadet Capt. G. H. MERWIN,	assigned to Company A.
Cadet Capt. T. S. BACON,	assigned to Company D.
Cadet Capt. J. E. GIFFORD,	assigned to Company B.
Cadet Capt. A. C. CURTIS,	assigned to Company C.
Cadet First Lieut. A. H. KIRKLAND,	assigned to Company A.
Cadet First Lieut. L. MANLEY,	assigned to Company D.
Cadet First Lieut. S. F. HOWARD,	assigned to Company B.
Cadet First Lieut R. E. SMITH,	assigned to Company C.
Cadet Second Lieut. C. H SPAULDING,	assigned to Company A.
Cadet Second Lieut. A J. MORSE,	assigned to Company D.
Cadet Second Lieut. H. M. FOWLER,	assigned to Company B.
Cadet Second Lieut. E. T. DICKINSON,	assigned to Company C.
Cadet First Sergeant R. A. COOLEY,	assigned to Company A.
Cadet First Sergeant F. L. WARREN,	assigned to Company D.
Cadet First Sergeant H. S. FAIRBANKS,	assigned to Company B.
Cadet First Sergeant H. A. BALLOU,	assigned to Company C.
Cadet Sergeant C. W. CREHORE,	assigned to Company B.
Cadet Sergeant M. J. SULLIVAN,	assigned to Company B.
Cadet Sergeant R. S. JONES,	assigned to Company A.
Cadet Sergeant J. MARSH,	assigned to Company A.
Cadet Sergeant W. L. MORSE,	assigned to Company D.
Cadet Sergeant C. B. LANE,	assigned to Company D.
Cadet Sergeant W. A. ROOT,	assigned to Company C.
Cadet Sergeant H. L. FROST,	assigned to Company C.

Cadet Corporal S. P. Toole, . . .	assigned to Company A.
Cadet Corporal F. C. Tobey, . . .	assigned to Company C.
Cadet Corporal A. B. Smith, . . .	assigned to Company C.
Cadet Corporal S. Kuroda, . . .	assigned to Company B.
Cadet Corporal H. E. Clark, . . .	assigned to Company D.
Cadet Corporal E. H. Henderson, . .	assigned to Company B.
Cadet Corporal H. D. Hemenway, . .	assigned to Company A.
Cadet Corporal C. M. Dickinson, . .	assigned to Company B.
Cadet Corporal E. A. White, . . .	assigned to Company D.
Cadet Corporal N. Shultis, . . .	assigned to Company A.
Cadet Corporal H. C. Burrington, . .	assigned to Company D.
Cadet Corporal F. L. Clapp, . . .	assigned to Company C.
Cadet Corporal P. A. Leamy, . . .	assigned to Company B.
Cadet Corporal F. E. DeLuce, . . .	assigned to Company A.
Cadet Corporal S. Saito, ...	assigned to Company C.
Cadet Corporal H. T. Edwards, . .	assigned to Company D.

Respectfully submitted,

W. M. DICKINSON,

Lieutenant United States Army.

CALENDAR FOR 1894–95.

1894.

January 3, Wednesday, winter term begins, at 8.15 A.M.

March 22, Thursday, winter term closes, at 10.30 A.M.

April 3, Tuesday, spring term begins, at 8.15 A.M.

June 17, Sunday,
- Baccalaureate sermon.
- Address before the College Young Men's Christian Association.

June 18, Monday,
- Western Alumni prize speaking.
- Grinnell prize examination of the senior class in agriculture.

June 19, Tuesday,
- Meeting of the alumni.
- Flint prize oratorical contest.
- Class day exercises.
- Military exercises.
- Reception by the president and trustees.

June 20, Wednesday, Commencement exercises.

June 21–22, Thursday and Friday, examinations for admission, at 9 A.M., Botanic Museum, Amherst; at Jacob Sleeper Hall, Boston University, 12 Somerset Street, Boston; and at the Sedgwick Institute, Great Barrington. Two full days are required for examination, and candidates must come prepared to stay that length of time.

September 4–5, Tuesday and Wednesday, examinations for admission, at 9 A.M., Botanic Museum.

September 6, Thursday, fall term begins, at 8.15 A.M.

December 19, Wednesday, fall term closes, at 10.30 A.M.

1895.

January 3, Thursday, winter term begins, at 8.15 A.M.

March 21, Thursday, winter term closes, at 10.30 A.M.

THE CORPORATION.

	Term expires.
FRANCIS H. APPLETON of Lynnfield,	1894
WILLIAM WHEELER of Concord,	1894
ELIJAH W. WOOD of West Newton,	1895
CHARLES A. GLEASON of New Braintree,	1895
DANIEL NEEDHAM of Groton,	1896
JAMES DRAPER of Worcester,	1896
HENRY S. HYDE of Springfield,	1897
MERRITT I. WHEELER of Great Barrington,	1897
JAMES S. GRINNELL of Greenfield,	1898
JOSEPH A. HARWOOD of Littleton,	1898
WILLIAM H. BOWKER of Boston,	1899
J. D. W. FRENCH of Boston,	1899
J. HOWE DEMOND of Northampton,	1900
ELMER D. HOWE of Marlborough,	1900

Members Ex Officio.

His Excellency Governor WILLIAM E. RUSSELL, *President of the Corporation.*

HENRY H. GOODELL, *President of the College.*

JOHN W. DICKINSON, *Secretary of the Board of Education.*

WILLIAM R. SESSIONS, *Secretary of the Board of Agriculture.*

JAMES S. GRINNELL of Greenfield,
Vice-President of the Corporation.

WILLIAM R. SESSIONS of Hampden, *Secretary.*

GEORGE F. MILLS of Amherst, *Treasurer pro tempore.*

CHARLES A. GLEASON of New Braintree, *Auditor.*

Committee on Finance and Buildings.*

JAMES S. GRINNELL. HENRY S. HYDE.
J. HOWE DEMOND. CHARLES A. GLEASON.
DANIEL NEEDHAM, *Chairman.*

Committee on Course of Study and Faculty.*

WILLIAM H. BOWKER. JOSEPH A. HARWOOD.
ELMER D. HOWE. J. D. W. FRENCH.
WILLIAM WHEELER, *Chairman.*

Committee on Farm and Horticultural Departments.*

ELIJAH W. WOOD. JAMES DRAPER.
FRANCIS H. APPLETON. MERRITT I. WHEELER.
WILLIAM R. SESSIONS, *Chairman.*

Committee on Experiment Department.*

DANIEL NEEDHAM. ELIJAH W. WOOD.
WILLIAM WHEELER. JAMES DRAPER.
WILLIAM R. SESSIONS, *Chairman.*

Board of Overseers.

THE STATE BOARD OF AGRICULTURE.

Examining Committee of Overseers.

CHAS. A. MILLS, ... of Southborough.
A. C. VARNUM, ... of Lowell.
DR. WILLIAM HOLBROOK, . . of Palmer.
GEORGE L. CLEMENCE, . . . of Southbridge,
GEORGE CRUICKSHANKS, . . of Fitchburg.
E. A. HARWOOD, ... of North Brookfield.

The Faculty.

HENRY H. GOODELL, LL.D., *President,*
Professor of Modern Languages and English Literature.

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* The president of the college is ex officio a member of each of the above committees.

LEVI STOCKBRIDGE,
Professor of Agriculture, Honorary.

CHARLES A. GOESSMANN, Ph.D., LL.D.,
Professor of Chemistry.

SAMUEL T. MAYNARD, B.Sc.,
Professor of Botany and Horticulture.

CLARENCE D. WARNER, B.Sc.,
Professor of Mathematics and Physics.

CHARLES WELLINGTON, Ph.D.,
Associate Professor of Chemistry.

CHARLES H. FERNALD, Ph.D.,
Professor of Zoölogy.

Rev. CHARLES S. WALKER, Ph D.,
Professor of Mental and Political Science.

WILLIAM P. BROOKS, B.Sc.
Professor of Agriculture.

GEORGE F. MILLS, M.A.,
Professor of English.

JAMES B. PAIGE, V.S.,
Professor of Veterinary Science.

WALTER M. DICKINSON, 1st Lieut. 17th Infantry, U. S. A.,
Professor of Military Science and Tactics.

A. COURTENAY WASHBURNE,
Assistant Professor of Mathematics.

HERMAN BABSON, B.A.,
Assistant Professor of English.

GEORGE E. STONE, Ph.D.,
Assistant Professor of Botany.

EDWARD R. FLINT, Ph.D.,
Assistant Professor of Chemistry.

FRED S. COOLEY, B.Sc.,
Assistant Professor of Agriculture and Farm Superintendent.

ROBERT W. LYMAN, LL.B.,
Lecturer on Farm Law.

HENRY H. GOODELL, LL.D.,
Librarian.

Graduates of 1893.*

Baker, Joseph (Boston Univ.), .	Dudley.
Bartlett, Fred Goff (Boston Univ.),	Hadley.
Clark, Henry Disbrow (Boston Univ.), ...	Plainfield.
Curley, George Frederick (Boston Univ.), ...	Upton.
Davis, Herbert Chester (Boston Univ.), ...	Amherst.
Goodrich, Charles Augustus (Boston Univ.), ...	Hartford, Ct.
Harlow, Francis Turner (Boston Univ.), ...	Marshfield.
Harlow, Harry James (Boston Univ.), ...	West Boylston.
Hawks, Ernest Alfred, . .	Williamsburg.
Henderson, Francis Howard (Boston Univ.), ...	Malden.
Howard, Edwin Carleton (Boston Univ.), ...	Wilbraham.
Hoyt, Franklin Sherman (Boston Univ.), ...	Cheshire, Ct.
Lehnert, Eugene Hugo (Boston Univ.), ...	Clinton.
Melendy, Alphonso Edward (Boston Univ.), ...	Sterling.
Perry, John Richards (Boston Univ.), ...	Boston.
Smith, Cotton Atwood (Boston Univ.), ...	North Hadley.
Smith, Fred Andrew (Boston Univ.), ...	Lynn.
Smith, Luther Williams (Boston Univ.), ...	Ashfield.

* The annual report, being made in October, necessarily includes parts of two academic years, and the catalogue bears the names of such students as have been connected with the college during any portion of the year 1893.

Staples, Henry Franklin (Boston Univ.),	Leominster.
Tinoco, Luiz Antonio Ferreira (Boston Univ.),	Campos, Rio Janeiro, Brazil.
Walker, Edward Joseph (Boston Univ.),	Clinton,
Total,	21

Senior Class.

Alderman, Edwin Hammond,	Middlefield.
Averell, Fred Gilbert,	Amherst.
Bacon, Linus Hersey,	Spencer.
Bacon, Theodore Spalding,	Natick.
Barker, Louis Morton,	Hanson.
Boardman, Edwin Loring,	Sheffield.
Brown, Charles Leverett,	Feeding Hills.
Curtis, Arthur Clement,	Brooklyn, N. Y.
Cutter, Arthur Hardy,	Pelham, N. H.
Davis, Perley Elijah,	Worcester.
Dickinson, Eliot Taylor,	Amherst.
Fowler, Halley Melville,	South Gardner.
Fowler, Henry Justin,	North Hadley.
Gifford, John Edwin,	Brockton.
Greene, Frederic Lowell,	Shrewsbury.
Greene, Ira Charles,	Fitchburg.
Higgins, Charles Herbert,	Dover.
Howard, Samuel Francis,	Wilbraham.
Keith, Thaddeus Fayette,	Fitchburg.
Kirkland, Archie Howard,	Norwich.
Lewis, Henry Waldo,	Rockland.
Lounsbury, Charles Pugsley,	Allston.
Manley, Lowell,	Brockton.
Mann, Henry Judson,	Maplewood.
Merwin, George Henry,	Westport, Ct.
Morse, Alvertus Jason,	Belchertown.
Morse, Elisha Wilson,	Brockton.
Parker, Frank Ingram,	Pittsfield.
Pomeroy, Robert Ferdinand,	South Worthington.
Putnam, Joseph Harry,	West Sutton.
Sanderson, William Edwin,	Hingham.
Shepard, Lucius Jerry,	Oakdale.
Smead, Horace Preston,	Greenfield.
Smith, George Eli,	Sheffield.
Smith, Ralph Eliot,	Newton Centre.

Spaulding, Charles Harrington, .	East Lexington.
Stockwell, Harry Griggs,* . .	Sutton.
Walker, Claude Frederic, . .	Amherst.
White, Elias Dewey, . . .	South Sherborn.
Total, ...	39

Junior Class.

Bagg, Edward Oren, . . .	West Springfield.
Ballou, Henry Arthur, . . .	West Fitchburg.
Bemis, Waldo Louis, . . .	Spencer.
Billings, George Austin, . .	South Deerfield.
Brown, William Clay, . . .	Peabody.
Burgess, Albert Franklin, . .	Rockland.
Clark, Edile Hale, . . .	Spencer.
Clark, Harry Edward, . . .	Wilbraham.
Cooley, Robert Allen, . . .	South Deerfield.
Crehore, Charles Winfred, . .	Chicopee.
Dickinson, Charles Morrison, .	Park Ridge, Ill.
Drury, Ralph Willard, . . .	Athol Centre.
Fairbanks, Herbert Stockwell, .	Amherst.
Foley, Thomas Patrick, . .	Natick.
Frost, Harold Locke, . . .	Arlington.
Goodell, John Stanton, . .	Amherst.
Hemenway, Herbert Daniel, .	Williamsville.
Henderson, Edward Harris, . .	Malden.
Jones, John Horace, . . .	Pelham.
Jones, Robert Sharp, . . .	Dover.
Kuroda, Shiro, ...	Yamanouchi,Kitamura,Japan.
Lane, Clarence Bronson, . .	Killingworth, Ct.
Marsh, Jasper, ...	Danvers Centre.
Mason, Amos Hall, . . .	Medfield.
Morse, Walter Levi, . . .	Middleborough.
Potter, Daniel Charles, . .	Fairhaven.
Read, Henry Blood, . . .	Westford.
Root, Wright Asahel, . . .	Deerfield.
Smith, Arthur Bell, . . .	North Hadley.
Stevens, Clarence Lindon, . .	Sheffield.
Sullivan, Maurice John, . .	Amherst.
Tobey, Frederick Clinton, . .	West Stockbridge.
Toole, Stephen Peter, . . .	Amherst.
Warren, Frank Lafayette, . .	Shirley.
White, Edward Albert, . .	Ashby.
Total, ...	35

* Died at Sutton, Mass., Oct. 18, 1893, of tubercular meningitis.

Sophomore Class.

Burrington, Horace Clifton, . .	Charlemont.
Clapp, Frank Lemuel, . . .	Dorchester.
Cook, Allen Bradford, . . .	Petersham.
Curley, Walter James, . . .	Upton.
Day, Gilbert, ...	South Groveland.
DeLuce, Frank Edmund, . .	Warren.
Dodge, William Bradford, . .	Jamaica Plain.
Edwards, Harry Taylor, . .	Chesterfield.
Fletcher, Stephen Whitcomb, .	Rock.
Green, Josiah Elton, . . .	Spencer.
Hammar, James Fabens, . .	Swampscott.
Harper, Walter Benjamin, . .	Wakefield.
Hayward, Ralph Lyon, . .	Uxbridge.
Hubbard, Guy Augustus, . .	Ashby.
Jones, Benjamin Kent, . .	Middlefield.
Kinney, Asa Stephen, . . .	Worcester.
Kinsman, Ernest Eugene, . .	Heath.
Kramer, Albin Maximilian, . .	Clinton.
Leamy, Patrick Arthur, . .	Petersham.
Marshall, James Laird, . .	South Lancaster.
Moore, Henry Ward, . . .	Worcester.
Morse, Sydney Levi, . . .	Foxborough.
Nichols, Robert Parker, . .	West Norwell.
Nutting, Charles Allen, . .	North Leominster.
Pentecost, William Lewis, . .	Worcester.
Poole, Erford Wilson, . . .	North Dartmouth.
Poole, Isaac Chester, . . .	North Dartmouth.
Rawson, Herbert Warren, . .	Arlington.
Read, Frederick Henry, . .	Wilbraham.
Robinson, Frank Dean, . .	Petersham.
Roper, Harry Howard, . .	East Hubbardston.
Saito, Seijiro, ...	Nemuro, Japan.
Sastré de Verand, Salome, . .	Tabasco, Mexico.
Scannell, Michael Edward, . .	Amherst.
Sellew, Merle Edgar, . . .	East Longmeadow.
Shaw, Frederic Bridgman, . .	South Amherst.
Shultis, Newton, ...	Medford.
Shurtleff, Walter Davis, . .	Carver.
Tsuda, George, ...	Tokyo, Japan.
Washburn, Frank Porter, . .	North Perry, Me.
Total, ...	40

Freshman Class.

Allen, Edward Bernard, . .	Brimfield.
Allen, Harry Francis, . . .	Northborough.
Allen, John William, . . .	Northborough.
Armstrong, Herbert Julius, . .	Sunderland.
Barclay, Frederick White, . .	Kent, Ct.
Barry, John Marshall, . . .	Boston.
Bartlett, James Lowell, . .	Salisbury.
Birnie, Alexander Cullen, . .	Ludlow.
Charmbury, Thomas Herbert, .	Amherst.
Cheney, Liberty Lyon, . .	Southbridge.
Clark, Lafayette Franklin, . .	West Brattleborough, Vt.
Colby, Frederick William, . .	Roxbury.
Coleman, Robert Parker, . .	West Pittsfield.
Cook, Maurice Elmer, . . .	Shrewsbury.
Drew, George Albert, . . .	Westford.
Eddy, John Richmond, . .	Boston.
Emrich, John Albert, . . .	Amherst.
Falby, Francis Rand, . . .	Northborough.
Farnsworth, Robert Leroy, . .	Turner's Falls.
Felch, Percy Fletcher, . . .	Ayer.
Fittz, Austin Hervey, . . .	Natick.
Goessmann, Charles Ignatius, .	Amherst.
Howe, Herbert Frank, . . .	North Cambridge.
Hubbard, George Caleb, . .	Sunderland.
Hunter, Herbert Colman, . .	South Natick.
King, Charles Austin, . . .	East Taunton.
Leavens, George Davison, . .	Pawtucket, R. I.
Mansfield, George Rogers, . .	Gloucester.
Millard, Frank Cowperthwait, .	North Egremont.
Norton, Charles Ayer, . . .	Lynn.
Nowell, Allen March, . . .	Winchester.
Palmer, Clayton Franklin, . .	Stockbridge.
Palmer, Edward Dwight, . .	Amherst.
Peters, Charles Adams, . .	Greendale.
Ranlett, Charles Augustus, . .	South Billerica.
Roberts, Percy Colton, . .	North Amherst.
Sherman, Carleton Farrar, . .	Jamaica Plain.
Sherman, Harry Robinson, . .	Dartmouth.
Smith, Jr., Philip Henry, . .	South Hadley Falls.
Stearns, Harold Everett, . .	Conway.
Vaughan, Robert Henry, . .	Worcester.
Walsh, Thomas Francis, . .	North Amherst.
Wiley, Samuel William, . .	Amherst.
Total, ...	43

First Year.

Bailey, George Henry,	Middleborough.
Bagg, Elisha Aaron,	West Springfield.
Beaman, Dan Ashley,	Leverett.
Burnham, George Louis,	Andover.
Delano, Charles Wesley,	North Duxbury.
Dutton, Arthur Edwin,	Chelmsford.
Eaton, Williams,	North Middleborough.
Gibbs, Meltiah Tobey,	New Bedford.
Hall, Albert Durrell,	West Newton.
Hooker, William Anson,	Amherst.
Huntress, Louis Maynard,	Westfield.
Kimball, Asa Howard,	Melrose Highlands.
King, Charles Jerome,	South Amherst.
Lane, Frank Pitkin,	Oak Park, Ill.
Nims, Frank Linnaeus,	Amherst.
Rice, Benjamin Willard,	Northborough.
Rising, Albert Shepard,	Westfield.
Sweetser, Frank Eaton,	Danvers.
Tisdale, Charles Ernest,	Amherst.
Tisdale, Fred Alvin,	Amherst.
Todd, Frederick Gage,	Dorchester.
Wentzell, William Benjamin,	Amherst.
Wolcott, Herbert Raymond,	Amherst.
Total,	23

Resident Graduates at the College and Experiment Stations.

Arnold, B.Sc., Frank Luman (Boston Univ.),	Belchertown.
Carpenter, B.Sc., Malcolm Austin (Boston Univ.),	Leyden.
Court, William Boyce (Magill Univ.),	Montreal, Canada.
Crocker, B.Sc., Charles Stoughton (Boston Univ.),	Sunderland.
Haskins, B.Sc., Henry Darwin (Boston Univ.),	North Amherst.
Holland, B.Sc., Edward Bertram (Boston Univ.),	Amherst.
Johnson, B.Sc., Charles Henry (Boston Univ.),	Prescott.

Jones, B.Sc., Charles Howland (Boston Univ.), . . .	Downer's Grove, Ill.	
Shepardson, B.Sc., William Martin (Boston Univ.), ...	Warwick.	
Smith, B.Sc., Frederic Jason (Boston Univ.), . . .	North Hadley.	
Smith, B.Sc., Robert Hyde (Boston Univ.), ...	Amherst.	
Thabue, Koli San (Mich. Agr'l College), ...	Bassein, Burmah.	
Thomson, B.Sc., Henry Martin (Boston Univ.), . . .	Monterey.	
Total, ...		13

Summary.

Four-years course :		
Resident graduates, ...	13	
Graduates of 1893, ...	21	
Senior class, ...	39	
Junior class, ...	35	
Sophomore class, ...	40	
Freshman class, ...	43	
	——	191
Two-years course :		
First year, ...	23	23
Total, ...		214

FOUR-YEARS COURSE OF STUDY.

FRESHMAN YEAR.

	Agriculture.	Botany and Horticulture.	Chemistry.	Natural History.	Mathematics.	Latin and English.	French and Social Science.	Drawing and Military.
Fall, .	- - -	Botany, structural, — 5.	- - -	- - -	Advanced Algebra, — 5. Book-keeping, — 2.	Latin, — 4. English, — 2.	- -	Study of tactics, — 1.
Winter, .	History of agriculture, soils and soil formation, — 4.	- - -	- - -	- - -	Geometry, (plane and solid), — 4.	Latin, — 4. English, — 2.	- -	Free-hand drawing, — 6.
Summer, .	Improvements and characteristics of soils, drainage, etc., — 4.	Botany, analytical, — 4.	Chemistry, — 3.	- - -	Trigonometry, — 3.	Latin, — 3. English, — 2.	- -	- -

SOPHOMORE YEAR.

	Agriculture.	Botany and Horticulture.	Chemistry.	Natural History.	Mathematics.	Latin and English.	French and Social Science.	Drawing and Military.
Fall, .	Irrigation, disposition of sewage, manures and fertilizers, — 4.	Botany, economic, — 4.	Chemistry, — 4.	- - -	Mensuration, — 2.	English, — 2.	French, — 4.	- -
Winter, .	- - -	Laboratory work, — 4.	Chemistry, — 4.	Anatomy and physiology, — 4.	- -	English, — 2.	French, — 4.	Mechanical drawing, — 5.
Summer, .	Relations of the atmosphere to farming, mowings, pastures, grasses, ensilage, — 5.	Horticulture, — 5.	Chemistry, — 3.	- - -	Surveying, — 4.	English, — 2.	French, — 3.	- -

Four-Years Course of Study — Concluded.

JUNIOR YEAR.

	Agriculture.	Botany and Horticulture.	Chemistry.	Natural History.	Mathematics.	Latin and English.	French and Social Science.	Drawing and Military.
Fall,	Field crops, seed raising, production and improvement of varieties, machines and implements, — 4.	Market gardening, — 3.	Chemistry, — 5.	Zoölogy, laboratory work, — 8.	– –	Rhetoric and composition, — 4.	– –	– –
Winter,	Breeds and breeding of live stock, poultry farming, — 2.	– – –	Laboratory work, — 6.	Zoölogy, — 3.	Mechanics, — 5.	– –	Eng. lit, — 4.	Drawing, — 2.
Summer,	– – –	Landscape gardening, — 5.	Laboratory work, — 5.	Entomology, — 6.	Physics, — 4.	English, — 2.	– –	– –

* SENIOR YEAR (ELECTIVE).

	Agriculture.	Botany and Horticulture.	Chemistry.	Natural History.	Mathematics.	Latin and English.	French and Social Science.	Drawing and Military.
Fall,	Dairy farming, — 5.	Botany, cryptogamic, — 3. Forestry, — 2.	Chemistry, — 5.	Entomology, — 5. Veterinary science, — 5.	Electricity, — 5. Mathematics, — 5.	English, — 2.	Political economy, — 5. German, — 5.	Military science, — 1.
Winter,	Cattle feeding, — 5.	Fungi, laboratory work, — 2. Forestry, — 3.	Chemistry, — 5.	Entomology, — 5. Veterinary science, — 5.	Electricity, — 5. Mathematics, — 5.	English, — 2	Political economy, — 5. German, — 5.	Military science, — 1. Law lectures, — 1.
Summer,	Experimental work in agriculture, — 5.	Advanced botany, — 5.	Chemistry, — 5.	Entomology, — 5. Veterinary science, — 5.	Electricity, — 5. Mathematics, — 5.	English, — 2.	Constitutional history, — 5. German, — 5.	Military science, — 1.

* English and military science are required; of the other studies three at least must be chosen.

TWO-YEARS COURSE OF STUDY.

First Year.

	Agriculture.	Botany and Horticulture.	Chemistry.	Mathematics.	English.	Natural History.	Drawing and Military.
Fall, .	Soils, drainage, irrigation, — 5.	Structural and systematic botany, — 3.	- - -	Commercial arithmetic and algebra, — 5.	English grammar, — 3.	- -	Study of tactics, — 1. Drawing, — 6.
Winter, .	Manures, fertilizers and their use, — 3.	Horticulture and greenhouse work, — 5.	Elementary chemistry, lectures, — 3. Laboratory work, — 4.	Algebra and plane geometry, — 5.	English grammar, — 3.	- -	- -
Summer, .	Farm implements and machinery, — 3.	Systematic and economic botany, — 4. Fruit culture, — 5.	Elementary chemistry, lectures, — 3.	Solid geometry, — 3.	Composition and rhetoric, — 3.	- -	- -

Second Year.

	Agriculture.	Botany and Horticulture.	Chemistry.	Mathematics.	English.	Natural History.	Drawing and Military.
Fall, .	Field crops, farm accounts, — 3.	Market gardening and landscape gardening, — 5.	Chemistry of the farm, lectures, — 3.	Trigonometry and mensuration, — 3.	Composition and rhetoric, — 3.	Zoölogy and physiology, — 5.	- -
Winter, .	Live stock, breeds and breeding, — 4.	Forestry and greenhouse work, — 4.	Practice in agricultural chemical analysis, laboratory work, — 4.	Book-keeping, — 2.	Composition and declamation, — 3.	Veterinary, — 5.	- -
Summer, .	Cattle feeding and dairying, — 3.	- - -	- - -	Surveying, — 8.	Composition and declamation, — 3.	Veterinary, — 5. Entomology, — 6.	- -

TWO-YEARS COURSE.

Agriculture. — Lecture and text-book work in the study of soils, formation, composition and physical character; tillage; drainage; irrigation; manures and fertilizers; farm implements and machinery, and their use; field crops; grasses and forage plants; ensilage; mowings; pastures; farm buildings; roads and fences; the breeds of cattle, sheep, horses and swine; stock breeding and feeding; dairy farming; poultry farming; markets and marketing. The work will be made as practical as possible, and will be continually illustrated in field, barns, dairy and laboratory. Many of the lectures will be of the nature of outdoor talks. Practical training will be given when needed or desired. Time allotted, two hundred and twenty-two hours.

Botany. — Elementary botany, to impart general knowledge of the structure of seeds and plants, methods of reproduction and propagation, hybridization, methods of analysis of agricultural plants, especially grasses and weeds; plant diseases, and peculiarities of trees of economical importance. Herbarium of plants of agricultural importance to be required. Time allotted, one hundred and thirty hours.

Chemistry. — Elementary chemistry; principles of the science; chemical physics; chemistry of elements important to the farmer; chemistry of soils, plants, animals, foods and fertilizers. Time allotted, one hundred and fifty hours.

English. — Thorough drill in writing and speaking. Time allotted, two hundred and eleven hours.

Horticulture, Floriculture and Forestry. — Time allotted, one hundred and eighty-five hours.

Latin. — Elective. Designed for those intending to enter the four-years course.

Mathematics. — Algebra through quadratics; geometry, two books; trigonometry and plane surveying; topography; roads, location and construction; elementary mechanics and physics; book-keeping. Time allotted: Class-room, two hundred and thirty hours; field work, ninety hours; drawing, ninety hours.

Physiology, Zoölogy and Entomology. — Time allotted, one hundred and thirty hours.

Veterinary Science. — Comparative anatomy and physiology; hygiene; treatment of emergency cases; diagnosis and treatment of simple cases. Time allotted, one hundred and eleven hours.

GRADUATE COURSE.

1. No honorary degrees shall be conferred.

2. No applicant shall be eligible to the degree of M.S. until he has received the degree of B.S. or its equivalent.

3. The faculty shall offer a course of study in each of the following subjects: Mathematics and physics; chemistry; agriculture and botany; entomology; veterinary. Upon the satisfactory completion of any two of these, the applicant shall receive the degree of M.S. This prescribed work may be done in the Massachusetts Agricultural College or at any institution that the applicant may choose; but in either case the degree shall be conferred only after the applicant has passed an examination at the college under such rules and regulations as may be prescribed.

4. Every student in the graduate course shall pay one hundred dollars to the treasurer of the college before receiving the degree of M.S.

TEXT-BOOKS.

Wood — "The American Botanist and Florist."
Bessey — "Botany for High Schools and Colleges."
Gray — "Manual."
Gray — "Structural Botany."
Barnes — "Practical Botany,"
Barnes and Coulter — "Plant Dissection."
Campbell — "Structural and Systematic Botany."
Wolle — "Fresh-Water Algæ."
Long — "How to Make the Garden Pay."
Long — "Ornamental Gardening for Americans."
Fuller — "Practical Forestry."
Maynard — "Practical Fruit Grower."
McAlpine — "How to know Grasses by their Leaves."
Morton — "Soil of the Farm."
Gregory — "Fertilizers."
Mills and Shaw — "Public School Agriculture."
Miles — "Stock Breeding."
Armsby — "Manual of Cattle Feeding."
Shepard — "Elementary Chemistry."
Richter and Smith — "Text-book of Inorganic Chemistry."
Roscoe and Schorlemmer — "Treatise on Chemistry."
Medicus and Marshall — "Qualitative Analysis."
Wheeler — "Medical Chemistry."
Bernthsen and McGowan — "Text-book of Organic Chemistry."
Fresenius — "Qualitative Chemical Analysis."
Fresenius — "Quantitative Chemical Analysis."
Reynolds — "Experimental Chemistry."

SUTTON — "Volumetric Analysis."
DANA — "Manual of Mineralogy and Lithology."
BRUSH — "Manual of Determinative Mineralogy."
MILNE — "High School Algebra."
WELLS — "College Algebra."
DANA — "Mechanics."
WENTWORTH — "Plane and Solid Geometry."
CARHART — "Surveying."
WARNER — "Mensuration."
WELLS — "Plane and Spherical Trigonometry."
LOOMIS — "Analytical Geometry."
LOOMIS — "Differential and Integral Calculus."
JONES — "Sound, Light and Heat."
THOMPSON — "Electricity and Magnetism."
AYRTON — "Practical Electricity."
LOOMIS — "Meteorology."
GENUNG — "The Practical Elements of Rhetoric."
GENUNG — "Outlines of Rhetoric."
WILLIAMS — "Composition and Rhetoric."
WALKER — "Political Economy," abridged edition.
EMERSON — "Evolution of Expression."
LOCKWOOD — "Lessons in English."
COMSTOCK — "First Latin Book."
CÆSAR — "The Invasion of Britain."
WHITTIER, No. 4; LONGFELLOW, Nos. 33, 34, 35; LOWELL, No. 39 — "Riverside Literature Series."
SPRAGUE — "Six Selections from Irving's Sketch-book."
HUDSON — "Selections of Prose and Poetry." WEBSTER, BURKE, ADDISON, GOLDSMITH, SHAKESPEARE.
WHITNEY — "French Grammar."
KELLOGG — "English Literature."
WHITE — "Progressive Art Studies."

To give not only a practical but a liberal education is the aim in each department, and the several courses have been so arranged as to best subserve that end. Weekly exercises in composition and declamation are held throughout the course. The instruction in agriculture and horticulture is both theoretical and practical. A certain amount of labor is required of each student, and the lessons of the recitation room are practically enforced in the garden and field. Students are allowed to work for wages during such leisure hours as are at their disposal. Under the act by which the college was founded, instruction in military tactics is imperative, and each student, unless physically debarred,* is required to attend such exercises as are prescribed, under the direction of a regular army officer stationed at the college.

* Certificates of disability must be procured of Dr. Herbert B. Perry of Amherst.

FOUR-YEARS COURSE.

Admission.

Candidates for admission to the freshman class will be examined, orally and in writing, upon the following subjects: English grammar, geography, United States history, physiology, physical geography, arithmetic, the metric system, algebra (through quadratics), geometry (two books), civil government (Mowry's "Studies in Civil Government"), and Latin (grammar and first ten chapters of the first book of Cæsar's "Gallic War"), or an equivalent. The standard required is 65 per cent. on each paper. Diplomas from high schools will *not* be received in place of examination.

Candidates for higher standing are examined as above, and also in the studies gone over by the class to which they desire admission

No one can be admitted to the college until he is sixteen years of age. Every applicant is required to furnish a certificate of good character from his late pastor or teacher. The regular examinations for admission are held at the Botanic Museum, at 9 o'clock A.M., on Thursday and Friday, June 21 and 22, and on Tuesday and Wednesday, September 4 and 5; but candidates may be examined and admitted at any other time in the year. For the accommodation of those living in the eastern part of the State, examinations will also be held at 9 o'clock A.M., on Thursday and Friday, June 21 and 22, at Jacob Sleeper Hall, Boston University, 12 Somerset Street, Boston; and for the accommodation of those in the western part of the State, at the same date and time, at the Sedgwick Institute, Great Barrington, by James Bird. Two full days are required for examination and candidates must come prepared to stay that length of time.

TWO-YEARS COURSE.

Calendar the same as in the four-years course. Age for admission, fifteen years. The objects of this course are, primarily, to help farmers' sons and others, proposing to follow some branch of agriculture, who lack either the time or the means required for the longer course; secondly, in so far as practicable to serve as a preparation for the regular college course. Date of examination, same as for four-years course.

Admission.

Candidates for admission are examined, orally and in writing, in English grammar, geography, arithmetic and United States history. The standard required is 65 per cent. on each paper.

ENTRANCE EXAMINATION PAPERS USED IN 1893.

Arithmetic.

1. Find the least common multiple of 30, 32, 36, 40, 48.

2. Divide .006 by .06, multiply the quotient by .05 and divide the product by .005.

3. A man sold a farm for $2,760 and gained 15 per cent. on the cost. What was the cost?

4. What is the present worth and true discount of $1,609.30 due in 10 months, 24 days, current rate 5 per cent.?

5. Find the amount of $896 for 2 years, 6 months, 15 days, at $6\frac{2}{3}$ per cent.

6. London is 77° 1′ east of Washington. What is the time at Washington when it is noon at London?

7. A house was sold at an advance of 5 per cent. on the cost, for $13,000. What was the cost?

8. Goods which cost $35 are sold for $42. Find the profit per cent.

9. If $90 are paid for the work of 20 men 6 days, what should be paid for the work of 5 men 8 days?

10. How much will a load of wood 12 feet long, $4\frac{1}{2}$ feet wide, and 42 inches high cost at $8 per cord?

Metric System.

1. In what country and about what year did the metric system originate?

2. What are the principal units of the metric system?

3. Which of the principal units is the base of the metric system and what is its equivalent?

4. Change to meters and add 14.83 decameters, 756 hectometers and 948 centimeters.

5. At $1.25 a cubic meter, what will it cost to dig a trench 76.5 meters long, 2.2 meters wide, and 1.8 meters deep?

6. What must be the length of a bin 1 meter wide and 1 meter deep, to contain 4,500 liters of grain?

7. In 20 metric tons how many tons?

8. Change 18 quarts 1 pint to liters.

9. What would be the cost of a pile of wood 15.7 meters long, 3 meters high and 7.52 meters wide at $2.50 a stere?

10. In 2 miles, 6 furlongs, 39 rods and 5 yards, how many kilometers?

Algebra.

1. Define exponent, coefficient, axiom, and mention four kinds of symbols employed in algebra.
2. Name four methods of elimination.
3. Divide $15x^2 - x^4 - 20 - 2x^5 + 6x + 2x^3$ by $5 - 3x^2 - 4x + 2x^3$.
4. Factor the following expressions:
   $15 - 2x - x^2$; $x^2 - 14x + 45$; $27x^6 - 64y^3$.
5. Solve: $\frac{4x+3}{10} - \frac{12x-5}{5x-1} = \frac{2x-1}{5}$.
6. Extract the cube root of $x^6 + 6x^5 - 40x^3 + 96x - 64$.
7. Solve: $3x - 2y = 28$; $2x + 5y = 63$.
8. Add together $\sqrt[3]{\frac{1}{4}}$, $\sqrt[3]{\frac{1}{32}}$, $\sqrt[3]{\frac{2}{3}}$—
9. Solve:
   $$\sqrt{x^2 - 3x + 5} - \sqrt{x^2 - 5x - 2} = 1.$$
10. What fraction is that whose value, if 4 be added to the numerator, becomes $-\frac{1}{2}$; but if 7 be added to the denominator becomes $\frac{1}{5}$?

English Grammar and Composition.

Note. — Penmanship, spelling, capitalization and punctuation will be considered in determining the excellence of your paper. State whether you have studied Latin. If you have studied it, state how long and what you have read.

1. Name the parts of speech and state the office that each usually fulfills in a sentence.

2. Define each of the following terms used in grammar, and after each definition write an example: A word; a phrase; a clause; a compound sentence; a complex sentence.

3. Write in a column the names of eight punctuation marks, and opposite each make the mark named.

4. Analyze the above sentence.

5. Write the titles of any three books you have read since July 1, 1892. Write at least two hundred words on one of the following subjects:

(*a*) Any topic suggested by these books.
(*b*) An outline of any character found in them.
(*c*) Christopher Columbus.
(*d*) The life of a farmer.

6. From what you have written select two nouns, two pronouns, two transitive verbs, two intransitive verbs, and parse them in full.

7. Change the following to connected prose:

> He said to his friend, "If the British march
> By land or sea from the town to-night,
> Hang a lantern aloft in the belfry arch
> Of the North Church tower as a signal light —
> One, if by land, two, if by sea;
> And I on the opposite shore will be,
> Ready to ride and spread the alarm
> Through every Middlesex village and farm,
> For the country folk to be up and to arm."

8. Fill the blanks correctly with *shall* or *will*:
   (*a*) ——— there be time to call for it?
   (*b*) I ——— go and nobody ——— prevent me.
   (*c*) If you ——— call for me, I ——— be glad to go with you.

GEOGRAPHY.

NOTE. — Penmanship, spelling, capitalization, and punctuation will be considered in determining the excellence of your paper.

1. What causes the regular succession of day and night and of the seasons?

2. What are zones? How many are there? Which of these has the greatest land surface?

3. Name two peninsulas on the eastern coast of North America and two on the western.

4. Mention three parallel ranges of the Appalachian system of mountains.

5. On what lakes would one sail in going by water from Detroit to Chicago?

6. Draw an outline map of Massachusetts and the boundary lines of each county in the State. Locate the place and the county-seat of the county in which you live.

7. In which State and on what water is each of the following cities located: Chicago? Kansas City? Harrisburg? Mobile? Portsmouth? Charleston? Galveston? Philadelphia? Fall River? Yankton?

8. Draw an outline map of the Mediterranean Sea, and name and locate the countries of Europe that border on it.

9. What bodies of water are separated, and what countries or political divisions are connected, by the following: —

(*a*) The Isthmus of Panama?

(*b*) The Isthmus of Suez?

10. Name two countries bordering on the Baltic Sea and the capital of each.

United States History.

Note. — Penmanship, spelling, capitalization, and punctuation will be considered in determining the excellence of your paper.

1. Who discovered America? When? What part of America did he discover? What reward did he receive?

2. Who discovered the continent of North America?

3. When and where was the first permanent English settlement made in the United States? What was the first settlement made by the Dutch?

4. Write in full the names of the thirteen colonies that became the thirteen original States. By what nation was each of these colonies founded?

5. Mention a prominent battle of the French and Indian war; the Revolutionary war; the war of 1812; the Mexican war; the war of the rebellion.

6. Where was the Continental Congress in session during the Revolutionary war? When was Washington made the capital city of the United States?

7. What prominent events are associated with the following dates: 1620? 1775? 1781? 1787? 1861? 1865?

8. Name some of the important inventions made by Americans.

9. Name three prominent centennial celebrations by the people of the United States and give the date of each. In what city and in what building was the Declaration of Independence signed?

10. Name the first six Presidents of the United States in the order of their administration. Which Presidents died in office? Name any three members of President Cleveland's Cabinet.

DEGREES.

Those who complete the four-years course receive the degree of Bachelor of Science, the diploma being signed by the governor of Massachusetts, who is president of the corporation.

Regular students of the college may also, on application, become members of Boston University, and upon graduation receive

its diploma in addition to that of the college, thereby becoming entitled to all the privileges of its alumni.

A diploma will be awarded to those completing the two-years course. Those completing the graduate course receive the degree of Master of Science.

EXPENSES.

Tuition, in advance: --			
Fall term,	$30 00		
Winter term,	25 00		
Summer term,	25 00		
		$80 00	$80 00
Room rent, in advance, $8 to $16 per term,		24 00	48 00
Board, $2.50 to $5 per week,		95 00	190 00
Fuel, $5 to $15,		5 00	15 00
Washing, 30 to 60 cents per week,		11 40	22 80
Military suit,		15 75	15 75
Expenses per year,		$231 15	$371 55

Board in clubs has been $2.45 per week; in private families, $4 or $5. The military suit must be obtained immediately upon entrance at college, and used in the drill exercises prescribed. For the use of the laboratory in practical chemistry there will be a charge of $10 per term used, and also a charge of $4 per term for the expenses of the zoölogical laboratory. Some expense will also be incurred for lights and for text-books. Students whose homes are within the State of Massachusetts can in most cases obtain a scholarship by applying to the senator of the district in which they live.

THE LABOR FUND.

The object of this fund is to assist those students who are dependent either wholly or in part on their own exertions, by furnishing them work in the several departments of the college. The greatest opportunity for such work is found in the agricultural and horticultural departments. Application should be made to Prof. William P. Brooks and Samuel T. Maynard, respectively, in charge of said departments. Students desiring to avail themselves of its benefits must bring a certificate signed by one of the selectmen of the town in which they are resident, certifying to the fact that they require aid.

ROOMS.

All students, except those living with parents or guardians, will be required to occupy rooms in the college dormitories.

For the information of those desiring to carpet their rooms, the following measurements are given: In the new south dormitory the study rooms are about fifteen by fourteen feet, with a recess seven feet four inches by three feet; and the bedrooms are eleven feet two inches by eight feet five inches. This building is heated by steam. In the north dormitory the corner rooms are fourteen by fifteen feet, and the annexed bedrooms eight by ten feet. The inside rooms are thirteen and one-half feet by fourteen and one-half feet, and the bedrooms eight by eight feet. A coal stove is furnished with each room. Aside from this, all rooms are unfurnished. Mr. Thomas Canavan has the general superintendence of the dormitories, and all correspondence relative to the engaging of rooms should be with him.

SCHOLARSHIPS.

Established by Private Individuals.

Mary Robinson Fund of one thousand dollars, the bequest of Miss Mary Robinson of Medfield.

Whiting Street Fund of one thousand dollars, the bequest of Whiting Street, Esq., of Northampton.

Henry Gassett Fund of one thousand dollars, the bequest of Henry Gassett, Esq., of North Weymouth.

The income of the above funds is assigned by the faculty to worthy students requiring aid.

CONGRESSIONAL SCHOLARSHIPS.

The trustees voted in January, 1878, to establish one free scholarship for each of the congressional districts of the State. Application for such scholarships should be made to the Representative from the district to which the applicant belongs. The selection for these scholarships will be determined as each member of Congress may prefer; but, where several applications are sent in from the same district, a competitive examination would seem to be desirable. Applicants should be good scholars, of vigorous constitution, and should enter college with the intention of remaining through the course, and then engaging in some pursuit connected with agriculture.

STATE SCHOLARSHIPS.

The Legislature of 1883 passed the following resolve in favor of the Massachusetts Agricultural College : —

Resolved, That there shall be paid annually, for the term of four years, from the treasury of the Commonwealth to the treasurer of the Massachusetts Agricultural College, the sum of ten thousand dollars, to enable the trustees of said college to provide for the students of said institution the theoretical and practical education required by its charter and the law of the United States relating thereto.

Resolved, That annually, for the term of four years, eighty free scholarships be and hereby are established at the Massachusetts Agricultural College, the same to be given by appointment to persons in this Commonwealth, after a competitive examination, under rules prescribed by the president of the college, at such time and place as the senator then in office from each district shall designate ; and the said scholarships shall be assigned equally to each senatorial district. But, if there shall be less than two successful applicants for scholarships from any senatorial district, such scholarships may be distributed by the president of the college equally among the other districts, as nearly as possible ; but no applicant shall be entitled to a scholarship unless he shall pass an examination in accordance with the rules to be established as hereinbefore provided.

The Legislature of 1886 passed the following resolve, making perpetual the scholarships established : —

Resolved, That annually the scholarships established by chapter forty-six of the resolves of the year eighteen hundred and eighty-three be given and continued in accordance with the provisions of said chapter.

In accordance with these resolves, any one desiring admission to the college can apply to the senator of his district for a scholarship. Blank forms of application will be furnished by the president.

EQUIPMENT.

Agricultural Department.

The Farm. — Among the various means through which instruction in agriculture is given, none exceeds in importance the farm. The part which is directly under the charge of the professor of agriculture comprises about one hundred and fifty acres of improved land and thirty acres of woodland. Of the improved land, about thirty acres are kept permanently in grass, and managed

partly with a view to landscape effect. A considerable share of this land is, however, laid off in half and quarter acre plats, and variously fertilized with farmyard and stable manures and chemicals, with a view to throwing light upon the economical production of grass. These plats are staked and labeled, so that all may see exactly what is being used and what are the results.

The balance of the farm is managed under a system of rotation, all parts being alternately in grass and hoed crops. All the ordinary crops of this section are grown, and many not usually seen upon Massachusetts farms find a place here. Our large stock of milch cows is almost entirely fed in the barn, and fodder crops occupy a prominent place. Experiments of various kinds are continually under trial; and every plat is staked and bears a label stating variety under cultivation, date of planting, and manures and fertilizers used.

Methods of land improvement are constantly illustrated here, tile drainage especially receiving a large share of attention. There are now some nine miles of tile drains in successful and very satisfactory operation upon the farm. Methods of clearing land of stumps are also illustrated, a large amount of such work having been carried on during the last few years.

In all the work of the farm the students are freely employed, and classes are frequently taken into the fields; and to the lessons to be derived from these fields the students are constantly referred.

The Barn and Stock. — Our commodious barns contain a large stock of milch cows, many of which are grades; but the following pure breeds are represented by good animals, viz.: Holstein-Friesian, Ayrshire, Jersey, Guernsey, and Shorthorn. Experiments in feeding for milk and butter are continually in progress.

We have a fine flock of Southdown sheep; swine are represented by the small Yorkshire and Tamworth breeds; and besides work horses we have a number of pure-bred Percherons used for breeding as well as for work. The barn is equipped with a view to illustrating different methods of fastening animals, styles of mangers, etc. Connected with it are an engine-room, storage-rooms for vehicles, machinery and tools, and a granary. It contains three silos and a root cellar.

A very large share of the work in the barn is performed by students, and whenever points require illustration, classes are taken to it for that purpose.

Dairy Room. — Connected with the farm-house is a model dairy room, containing Cooley creamers, by means of which our cream is for the most part raised. We are provided also with milk coolers and aerators of several patterns, churns, separator, butter-workers, etc. The various processes connected with the creaming

of milk, the preparation of milk for market and the manufacture of butter are illustrated here before our classes.

Equipment of Farm. — Aside from machines and implements generally found upon farms, the more important of those used upon our farm and in our barn which it seems desirable to mention are the following: Reversible sulky plough, broadcast fertilizer distributer, manure-spreader, grain-drill, horse corn-planter, potato-planter, wheelbarrow grass-seeder, hay-loader, potato-digger, hay-press, fodder cutter and crusher, and grain mill. It is our aim to try all novelties as they come out, and to illustrate everywhere the latest and best methods of doing farm work.

Lecture Room. — The agricultural lecture room in south college is well adapted to its uses. It is provided with numerous charts and lantern slides, illustrating the subjects taught. Connected with it are two small rooms at present used for the storage of illustrative material, which comprises soils in great variety, all important fertilizers and fertilizer materials, implements used in the agriculture of our own and other countries, and a collection of grasses and forage plants, grains, etc.

An important addition to our resources made during the past year consists of a full series of Landsberg's Models of Animals. These are accurate models of selected animals of all the leading breeds of cattle, horses, sheep and swine, and from one-sixth to full size, according to subject. We are provided with a complete collection of seeds of all our common grasses and the weeds which grow in mowings, and have also a large collection of the concentrated food stuffs. All these are continually used in illustration of subjects studied.

Museum. — An important beginning has been made towards accumulating materials for an agricultural museum. This is to contain the rocks from which soils have been derived, soils, fertilizer materials and manufactured fertilizers, seeds, plants and their products, stuffed animals, machines and implements. It is expected to make this collection of historical importance by including in it old types of machines and implements, earlier forms of breeds, etc. For lack of room, the material thus far accumulated, which is considerable, is stored in a number of scattered localities, and much of it where it cannot be satisfactorily exhibited.

Botanic Department.

The equipment of the botanic department has been collected for the two-fold purpose of supplementing instruction in the science of botany and in the various lines of horticultural work, as fruit

culture, market gardening, forestry, floriculture and landscape gardening.

For teaching botany proper, the equipment is as follows: —

The Botanic Museum, containing the Knowlton Herbarium, of over ten thousand species and varieties of phanerogamous and the higher cryptogamous plants, over two thousand species of fungi and several collections of lichens and mosses. It also contains a large collection of native woods, cut so as to show their individual structure; numerous models of native fruits; specimens of abnormal and peculiar forms of stems, fruit, vegetables, etc.; many interesting specimens of unnatural growths of trees and plants, natural grafts, etc.; together with many specimens and models prepared for illustrating the growth and structure of plants, and including a model of the squash which raised by the expansive force of its growing cells the enormous weight of five thousand pounds.

The Botanic Lecture Room, in the same building, is provided with diagrams and charts of over three thousand figures, illustrating structural and systematic botany.

The Botanic Laboratory, with provision for twenty-five students to work at one time, is equipped with twenty-three compound microscopes, including the makes of R. B. Tolles, J. W. Queen & Co., R. & J. Beck and Bausch & Lomb, with objectives ranging from four-inch to one-fifteenth inch focal lengths, and all the accessory apparatus requisite for a thorough study of plant structure and plant physiology. Special attention is here given to the study of the common and useful plants cultivated on the farm, in the garden and under glass, and to the study of all fungous and other parasitic plant growth attacking our farm and garden crops. Apparatus for photographing microscopic sections as well as outdoor objects, and special books needed for reference by the students while at work in the laboratory, have recently been added.

Greenhouses. — To aid in the instruction of botany as well as that of floriculture and market gardening, the glass structures contain a large collection of plants of a botanical and economic value, as well as those grown for commercial purposes. They consist of a large octagon, forty by forty feet, with sides twelve feet high and a central portion over twenty feet high, for the growth of large specimens, like palms, tree ferns, the bamboo, banana, guava, olive, etc.; a lower octagon, forty by forty feet, for general greenhouse plants; a moist stove, twenty-five by twenty-five feet; a dry stove, twenty-five by twenty-five feet; a rose room, twenty-five by twenty feet; a room for aquatic plants,

twenty by twenty-five feet; a room for ferns, mosses and orchids, eighteen by thirty feet; a large propagating house, fifty by twenty-four feet, fitted up with benches sufficient in number to accommodate fifty students at work at one time; a vegetable house, forty-two by thirty-two feet; two propagating pits, eighteen by seventy-five feet, each divided into two sections for high and low temperatures, and piped for testing overhead and under-bench heating; a cold grapery eighteen by twenty-five feet. To these glass structures are attached three work-rooms, equipped with all kinds of tools for greenhouse work. In building these houses as many as possible of the principles of construction, heating and ventilating, etc., have been incorporated for purposes of instruction.

For instruction in horticulture are: —

Orchards. — The orchards are extensive, and contain nearly all the valuable leading varieties, both old and new, of the large fruits, growing under various conditions of soil and exposure.

Small Fruits. — The small fruit plantations contain a large number of varieties of each kind, especially the new and promising ones, which are compared with older sorts, in plots and in field culture. Methods of planting, pruning, training, cultivation, study of varieties, gathering, packing and shipping fruits, etc., are taught by field exercises, the students doing a large part of the work of the department.

Nursery. — This contains more than five thousand trees, shrubs and vines, in various stages of growth, where the different methods of propagation by cuttings, layers, budding, grafting, and pruning and training are practically taught to the students.

Garden. — All kinds of garden and farm-garden crops are grown in this department, furnishing ample illustration of the treatment of all market garden crops. The income from the sales of trees, plants, flowers, fruit and vegetables aids materially in the support of the department, and furnishes illustrations of the methods of business, with which all students are expected to become familiar.

Forestry. — Many kinds of trees suitable for forest planting are grown in the nursery, and plantations have been made upon the college grounds and upon private estates in the vicinity, affording good examples of this most important subject. A large forest grove is connected with this department, where the methods of pruning trees and the management and preservation of forests can be illustrated. In the museum and lecture room are collections of native woods, showing their natural condition and peculiarities; and there have been lately added the prepared wood sections of R. B. Hough, mounted on cards for class-room illustrations.

Ornamental trees, shrubs and flowering plants are grouped about the grounds in such a way as to afford as much instruction as possible in the art of landscape gardening. All these, as well as the varieties of large and small fruits, are marked with conspicuous labels, giving their common and Latin names, for the benefit of the students and the public.

Tool House. — A tool house, thirty by eighty feet, has just been completed, containing a general store-room for keeping small tools, a repair shop with forge, anvil and work bench, and open sheds for housing wagons and large tools. Under one-half of this building is a cellar for storing fruit and vegetables. In the loft is a chamber, thirty by eighty feet, for keeping the hotbed sashes, shutters, mats, berry crates, baskets and other materials when not in use.

Connected with the stable is a cold-storage room, with an ice chamber over it, for preserving fruit, while the main cellar underneath the stable is devoted to the keeping of vegetables.

The great need of this department is funds with which to purchase manures and fertilizers for keeping the grounds and orchards in a satisfactory condition of growth. A part of the garden land south of the greenhouses has been greatly improved by underdraining and the tile are on the ground for putting the remainder into a condition for profitable cultivation.

A Massachusetts Garden.

The proposition to devote the hillside in the south east corner of the farm to the growth of the trees and plants of Massachusetts is one that should be carried out, thus adding a very useful as well as beautiful feature to the grounds.

The location of the college is one of the most beautiful to be found in the State, and the ornamentation of the banks of the beautiful sheet of water between the botanic department and the main college buildings, as well as the hillside above the greenhouses, will do more than any one thing to make the college grounds noted for their finished beauty as a combination of art and nature.

Zoölogical Department.

Zoölogical Lecture Room. — The room in south college is well adapted for lecture and recitation purposes, and is supplied with a series of zoölogical charts prepared to order, also a set of Leuckart's charts, disarticulated skeletons, and other apparatus for illustrating the lectures in the class-room.

Zoölogical Museum. — This is in immediate connection with the

lecture room, and contains the Massachusetts State collection, which comprises a large number of mounted mammals and birds, together with a series of birds' nests and eggs, a collection of alcoholic specimens of fishes, reptiles and amphibians, and a collection of shells and other invertebrates.

There is also on exhibition in the museum a collection of skeletons of our domestic and other animals, and mounted specimens purchased from Prof. H. A. Ward; a series of glass models of jelly fishes, worms, etc., made by Leopold Blaschka in Dresden; a valuable collection of corals and sponges from Nassau, N. P., collected and presented by Prof. H. T. Fernald; a fine collection of corals, presented by the Museum of Comparative Zoölogy in Cambridge; a collection of alcoholic specimens of invertebrates from the coast of New England, presented by the National Museum at Washington; a large and rapidly growing collection of insects of all orders, and a large series of clastique models of various animals, manufactured in the Auzoux laboratory in Paris. The museum is now open to the public from three to four P.M., every day except Saturday and Sunday.

Zoölogical Laboratory. — A large room in the laboratory building has been fitted up for a zoölogical laboratory, with tables, sink, gas, etc., and is supplied with a reference library, microscopes, chemical and other necessary apparatus for work. This laboratory with its equipment is undoubtedly the most valuable appliance for instruction in the department of zoölogy.

Veterinary Department.

This department is well equipped with the apparatus necessary to illustrate the subject in the class-room.

It consists of an improved Auzoux model of the horse, imported from Paris, constructed so as to separate and show in detail the shape, size, structure and relations of the different parts of the body; two papier maché models of the hind legs of the horse, showing disease of the soft tissues, — wind-galls, bogs, spavins, etc., also the diseases of the bone tissues, splint, spavins, and ring-bones; two models of the foot, one according to Bracy Clark's description, the other showing the Charlier method of shoeing and the general anatomy of the foot; a full-sized model of the bones of the hind leg, giving shape, size and position of each individual bone; thirty-one full-sized models of the jaws and teeth of the horse, and fourteen of the ox, showing the changes which take place in these organs as the animals advance in age.

There is an articulated skeleton of the famous stallion, Blackhawk; a disarticulated one of a thorough-bred mare, besides one

each of the cow, sheep, pig and dog; two prepared dissections of the fore and hind legs of the horse, showing the position and relation of the soft tissues to the bones; a papier maché model of the uterus of the mare and of the pig; a gravid uterus of the cow; a wax model of the uterus, placenta and fœtus of the sheep, showing the position of the fœtus and the attachment of the placenta to the walls of the uterus.

In addition to the above there is a growing collection of pathological specimens of both the soft and osseous tissues, and many parasites common to the domestic animals. A collection of charts and diagrams especially prepared for the college is used in connection with the lectures upon the subject of anatomy, parturition and conformation of animals.

Through the kindness of Mr. Henry Adams of Amherst the department has received a large sample collection of the various drugs used in the treatment of the diseases of the domestic animals.

For the benefit of the students, sick or diseased animals are frequently shown them, and operations performed in connection with the class-room work. For the use of the instructor of this department a laboratory has been provided in the old chapel building. It has been equipped with the apparatus necessary for the study of histology, pathology, and bacteriology, consisting in part of an improved Zeiss microscope with a one-eighteenth inch objective, together with the lower powers; a Lautenschlager's incubator and hot-air sterilizer; an Arnold's steam sterilizer and a Bausch & Lomb improved laboratory microtome. This apparatus is used for the preparation of material for the class-room and for general investigation.

Mathematical Department.

The instruction embraces pure mathematics, civil engineering, mechanics and physics. For civil engineering there are an Eckhold's omnimeter, solar transit, three engineer's transits, surveyor's transit, gradienter, plane table, two common compasses, two levels, one architect's compass level, six surveyor's chains, six levelling rods of various patterns, cross-section rod, and such other incidental apparatus as is necessary for practical field and railroad work.

For mechanics there is a full set of mechanical powers, and a good collection of apparatus for illustration in hydrostatics, hydrodynamics and pneumatics. There is also a supply of physical apparatus for illustrating the general principles of sound, heat and light.

For practical study in electricity there are several electrical machines; small hand dynamo with complete outfit of necessary apparatus, coils, standard one thousand ohm resistance box, Wheatstone's bridge, testing set, sine and tangent galvanometer, Thomson's reflecting galvanometer with shunt box and standard scale, electrometer, direct reading voltmeter and ammeter, and a large quantity of less expensive, but important apparatus for class-room illustration and laboratory work. Much of this collection is new, having been recently added, and thus the facilities for practical information in this department have been greatly increased.

The lecture room is large and adjacent to it is a work room and the physical cabinet.

Chemical Department.

Instruction in general, agricultural and analytical chemistry and mineralogy is given in the laboratory building. Thirteen commodious rooms, well lighted and ventilated and fitted at large expense, are occupied by the chemical department.

The Lecture Room, on the second floor, has ample seating capacity for seventy students. Immediately adjoining it are four smaller rooms which serve for storing apparatus and preparing material for the lecture table.

The Laboratory for beginners is a capacious room on the first floor. It is furnished with forty working tables. Each table is provided with sets of wet and dry reagents, a fume chamber, water, gas, drawer and locker, and apparatus sufficient to render the student independent of carelessness or accident on the part of others working near by; thus equipped each worker has the opportunity, under the direction of an instructor, of repeating the processes which he has previously studied at the lecture table and of carrying out, at will, any tests which his own observation may suggest.

A systematic study of the properties of elementary matter is here taken up, then the study of the simpler combinations of the elements and their artificial preparation.

Then follows qualitative analysis of salts, minerals, soils, fertilizers, animal and vegetable products.

The Laboratory for advanced students has just been fitted up in the room, also on the first floor, previously known as the chapel.

Here tables for thirty workers, besides large fume chambers and distillation tables with ample supplies of gas and water and all kinds of apparatus, have been arranged. This is for instruction in the chemistry of various manufacturing industries, especially those of agricultural interest, as the production of sugar, starch

fibres and dairy products; the preparation of plant and animal foods, their digestion, assimilation and economic use; the official analysis of fertilizers, fodders and foods, the analysis of soils and waters, of milk, urine, and other animal and vegetable products.

The Balance Room has four balances and improved apparatus for determining densities of solids, liquids and gases.

Apparatus and Collections. — Large purchases of apparatus have recently been made. Deficiencies caused by the wear and breakage of several years have been supplied and the original outfit increased. The various rooms are furnished with an extensive collection of industrial charts, including Lenoir & Foster's series and those of Drs. Julius and Georg Schroeder. The apparatus includes balances, a microscope, spectroscope, polariscope, photometer, barometer, and numerous models and sets of apparatus. A valuable and growing collection of specimens and samples, fitted to illustrate different subjects taught, is also provided. This includes rocks, minerals, soils, raw and manufactured fertilizers; food, including milling products; fibres and other vegetable and animal products, and artificial preparations of mineral and organic compounds. Series of preparations are used for illustrating the various stages of various manufactures from raw materials to finished products.

Military Department.

United States Property.

2	light twelve-pound bronze guns with implements.
2	eight-inch mortars with implements.
2	gun carriages.
2	mortar beds.
127	Springfield cadet rifles.
125	infantry accoutrements, sets.
31	headless shell extractors.
10,000	metallic ball cartridges.
1,600	metallic blank cartridges.
4,000	pasters.
125	targets, A and B.

Library.

This now numbers 14,235 volumes, having been increased during the year, by gift and purchase, 1,185 volumes. It is placed in the lower hall of the new chapel-library building, and is made available to the general student for reference or investigation. It is especially valuable as a library of reference, and no pains will be spared to make it complete in the departments of agriculture,

horticulture and botany, and the natural sciences. It is open a portion of each day for consultation, and an hour every evening for the drawing of books.

PRIZES.

Rhetorical Prizes.

The prizes heretofore offered by Isaac D. Farnsworth, Esq., will this year be given by the Western Alumni Association of the Massachusetts Agricultural College. These prizes are awarded for excellence in declamation and are open to competition, under certain restrictions, to members of the sophomore and freshman classes.

Military Prize.

A prize of fifteen dollars for the best essay on some military subject is offered this year to the graduating class by John C. Cutter, '72, and Charles H. Southworth, '77.

Flint Prizes.

Mr. Charles L. Flint of the class of 1881 has established two prizes, one of thirty dollars and another of twenty dollars, to be awarded, at an appointed time during commencement week, to the two members of the junior class who may produce the best orations. Excellence in both composition and delivery is considered in making the award.

Mathematical Prize.

Mr. Clarence D. Warner of the class of 1881 offers a prize of fifty dollars to that member of the senior class who shall pass the best written examination in the mathematics of the regular course.

Grinnell Agricultural Prizes.

Hon. William Claflin of Boston has given the sum of one thousand dollars for the endowment of a first and second prize, to be called the Grinnell Agricultural Prizes, in honor of George B. Grinnell, Esq., of New York. These two prizes are to be paid in cash to those two members of the graduating class who may pass the best written and oral examination in theoretical and practical agriculture.

Hills Botanical Prizes.

For the best herbarium collected by a member of the class of 1894, fifteen dollars is offered, and for the second best a prize of ten dollars; also a prize of five dollars for the best collection of

woods, and a prize of five dollars for the best collection of dried plants from the college farm.

The prizes in 1893 were awarded as follows: —

Flint Oratorical Prizes: Arthur C. Curtis (1894), first; Elias D. White (1894), second.

Western Alumni Rhetorical Prizes: Thomas P. Foley (1895), first; E. Hale Clark (1895), second; Frank L. Clapp (1896), first; Patrick A. Leamy (1896), second.

Military Prizes: Franklin S. Hoyt (1893), first; Eugene H. Lehnert (1893), second.

Grinnell Agricultural Prizes: Fred G. Bartlett (1893), first; Franklin S. Hoyt (1893), second.

Hills Botanical Prizes: Francis T. Harlow (1893), first; Henry F. Staples (1893), second.

RELIGIOUS SERVICES.

Students are required to attend prayers every week-day at 8.15 A.M., and public worship in the chapel every Sunday at 10.30 A.M., unless, by request of their parents, arrangements are made to attend divine service elsewhere. Further opportunities for moral and religious culture are afforded by a Bible class taught by one of the professors during the hour preceding the Sunday morning service, and by religious meetings held on Sunday afternoon and during the week, under the auspices of the College Young Men's Christian Association.

LOCATION.

Amherst is on the New London Northern Railroad, connecting at Palmer with the Boston & Albany Railroad, and at Miller's Falls with the Fitchburg Railroad. It is also on the Central Massachusetts Railroad, connecting at Northampton with the Connecticut River Railroad and with the New Haven and Northampton Railroad.

The college buildings are on a healthful site, commanding one of the finest views in New England. The large farm of three hundred and eighty-three acres, with its varied surface and native forests, gives the student the freedom and quiet of a country home.

APPENDIX.

THE TRUE VALUE OF GREEN MANURING.

By PROF. JULIUS KÜHN,

Director of the Agricultural Institute of Halle, Germany.

[Translated * and condensed by E. W. Allen, Ph.D.]

The practice of green manuring as a means of improving the fertility of the soil is one of the oldest in agriculture. It was advocated by Roman writers more than two thousand years ago, and from then till now lupine especially has been widely used for this purpose in southern France and Italy. Recently it has received a new impetus from discoveries made in plant nutrition, and is being vigorously advocated far and wide by writers on agricultural topics, without proper regard for the conditions under which it must prove an irrational practice.

The ancients knew that leguminous plants, especially the clovers, left the soil richer after their growth, even when the crop growing above ground was harvested, and they also knew that the soil was enriched in proportion to the size of the crop. Emil John found by a series of analyses more than forty years ago that this added richness did not consist alone in an increase in the humus-forming materials of the soil, but in an actual increase in the nitrogenous matter of the soil. The reason for all this, however, was not apparent until a few years ago. Investigations by Hellriegel, the director of a German experiment station, demonstrated the fact that leguminous plants have the ability to take up or assimilate the free nitrogen of the air and use it in their growth, and that they are enabled to do this by numerous tubercles or nodules which grow on their roots. The tubercles had been noticed before,

* From *Zeitschrift des landw. Central Vereins der Provinz Sachsen,* 1893, No. 1 pp. 3–13; No. 3, pp. 95–101; and No. 4, pp. 117–128.

but their function was unknown. Just how this assimilation of free nitrogen is effected is a problem not fully solved. Further studies have shown that the tubercles contain large numbers of microbes or micro-organisms, which appear to be responsible for the assimilation of nitrogen. It appears to be a result of their life processes. They live in a sort of partnership with the plants, deriving certain things essential to their life and growth from the juices of the plant, and in turn furnishing the plant with nitrogen. This partnership is known in science as symbiosis. Much remains to be found out regarding this mysterious process and it must be admitted that there is a certain amount of speculation in this theory. The question is an exceedingly difficult one to get at. But it is sufficient for practical purposes to know that leguminous plants provided with these tubercles possess a nitrogen source not available to other kinds of plants.

These discoveries throw a new light on green manuring and on the plants best adapted for green manuring. They show that while both leguminous and non-leguminous plants enriched the soil alike in humus-forming materials, in proportion to the size of the crop, they differ in respect to the source of their nitrogenous materials. While non-leguminous plants derive their nitrogen supply almost exclusively from the soil, leguminous plants take theirs from the free nitrogen of the air. Consequently, if spurry, rape, mustard, etc. (non-leguminous plants), are grown on the soil and the crop ploughed in, the soil is not materially enriched in nitrogen; the process is simply returning to the soil all the nitrogen which the crop took from it. Probably a very slight increase in nitrogen would occur, for it has been shown that all plants are able to absorb the traces of carbonate of ammonia in the air. But since leguminous plants may derive the large proportion of their nitrogen from without the soil — that is, from the air — their use for green manuring actually enriches the soil in nitrogenous matter; and, as a matter of fact, this is true in a high degree. This advantage of leguminous plants over other plants for green manuring increases the poorer the soil is naturally, and the less its ability to absorb the ammonia of the air. Leguminous plants which are adapted to grow on such poor soils and produce a large crop of green material are exceptionally valuable. The lupines possess these qualities in a high degree. Thus it is that the preference for this plant for green manuring, which has existed for more than two thousand years, is to-day fully explained and accounted for.

These are indeed facts of more than ordinary importance. They make it possible to practice green manuring far more intel-

ligently than previously. But it should be cautioned that these facts alone do not settle the practicability of green manuring. Other factors deserve careful consideration before it can be determined under what conditions green manuring may be regarded as an altogether rational and profitable operation, and under what conditions it is to be avoided in the interest of the greatest profit from the land.

Let us first consider the case of soils of doubtful value for cultivation, soils that raise the question as to whether they shall be brought into condition for culture or allowed to grow up to timber. Poor, sandy soils used for six, nine, or twelve years for rye, and remote from deposits of marl or muck, may be classed here. In such cases green manuring with lupine is of the greatest value and is far more promising financially than reforestation. Under a rotation of green manuring with lupine, with an application of kainit, and winter rye with Thomas slag phosphate, such a soil gradually improves in humus until the change is perceptible to the eye in the darker color of the soil. Accompanying this change in general appearance is an increase in fertility, until after a time a repetition of the green manuring once in three years will be sufficient. Meanwhile the winter rye may be followed by a crop of buckwheat instead of lupine. In this rotation of green manuring and rye, lime may usually be applied with advantage, preferably in the form of carbonate of lime, not burned lime.

In order to derive the greatest possible advantage from the green manuring, the lupine should be sown early in May, and not the last of May or in June, as is often recommended. By the first half of August, which is believed to be the best time of the year for ploughing under, the seed of the lupine will be nearly or quite formed, and the crop will contain the maximum quantity of nitrogenous matter. Four, or, better, six weeks should intervene between the ploughing under of the lupine and the sowing of the rye.

For the better class of sandy soils the rotation with green manuring mentioned above is too expensive. There the rye will do well even if the lupine is allowed to ripen and be harvested and the residue ploughed under. The farmer cannot afford to sacrifice a crop of lupine to green manuring, as in this case the lupine is the more valuable crop of the two. The lupine is to the light, sandy soils what the pea is to sandy loam soils and the horse bean to heavier soils, both as a preparatory crop and on account of its richly nitrogenous seeds. In the latter respect it surpasses the other papilionaceous plants, and the seed is well adapted to feeding cattle, horses, sheep, and goats. For feeding, the seed should

be disembittered by the Kellner* or some other method, and well bruised. The lupine seeds are then extremely valuable for feeding milch cows and fattening stock. In this way the lighter soil of the farm is made to furnish the necessary nitrogenous food at a relatively low cost.

To secure the best results, care is necessary in choosing the variety best adapted to the locality, and it will frequently be advisable to find this out by experimental trials. In the majority of cases, blue lupine gives an especially large yield of seed. Another point to be observed is the readiness with which the pods break open when ripe.

Since the lupine contains a poisonous principle, lupinose, only the seeds should be used for feeding, and these should be treated to remove this principle, as mentioned above. Both the green and dry forage are likely to disagree with animals, and the risk from their use is too great to be taken. The stems and straw should be used for bedding and incorporated with the manure.

Lupine may be employed in another way, namely, by sowing yellow lupine among the rye when the latter is in bloom and ploughing the crop under with the stubble. For reasons mentioned above, it must not be pastured. Following this light green manuring, potatoes or oats do well. When the soil is not suited to these crops, buckwheat is recommended. This latter form of lupine green manuring is one of the most valuable practices in the rational cultivation of sandy soils.

Serradella, also a leguminous plant, does well on medium light sandy soils. It may be sown, like lupine, among winter rye in spring. Under these conditions it produces an unusually luxuriant vegetation which may either be ploughed under, like lupine, and with equally good effect on the crop following, or it may be pastured. Serradella is an excellent fodder plant and may be fed with none of the danger attending the feeding of lupine. It may be fed either green, as hay, or as silage. It is eagerly eaten by all kinds of farm animals, retains its palatability and food value up to the end of blooming, and has a very favorable effect on the secretion of milk.

In view of these facts, the question arises, is the practice of ploughing under the crop of serradella an economical one? Would it not be better to feed the crop and plough under only the stubble

* Kellner's process of disembittering lupine seed consists in soaking the seed in water for twenty-four hours, with frequent changes of water, steaming for one hour, and then extracting for two days, with frequent stirring. In the latter operation the discolored water is drawn off frequently and fresh water added. Five pounds of this disembittered lupine seed may be fed to cows per day per 1,000 pounds live weight.

and the manure? In this connection, a calculation will throw some light upon the subject. Assuming an average crop of 17,600 pounds of green serradella per acre, which is a moderate crop, the nitrogen contained in the crop would be worth, at current prices, $11.06 per acre. This value of the nitrogen is taken as representing the total value of the crop for green manuring, since the nitrogen is the only fertilizing element not derived from the soil. The potash and phosphoric acid are merely returned to the soil from whence they came. The value of the humus-forming substances is not taken into account, as experiments by the author have shown this value to be very variable and in some cases entirely lacking.

A lengthy calculation of the value of the crop of 17,600 pounds of green serradella for feeding to milch cows, when the barnyard manure is returned to the soil, shows this to be $23.12. In this calculation every possible expense attending the feeding is taken into account, including care of animals, interest on money, cost of carting the barnyard manure to the land, etc., and allowance is made for the phosphoric acid and potash sold in the milk. The comparison stands then as follows: —

Value of crop of serradella from one acre, for feeding cows, .	$23.12
Value of crop of serradella from one acre, for green manuring,	11.06
Difference, ...	$12.06

This calculation shows the crop of serradella to be more than twice as valuable for feeding as for green manuring.

The above calculation assumed a daily milk yield of 7½ quarts, sold at 2¼ cents per quart. On the basis of only 1½ cents per quart of milk, the feeding value would be $13.52, or still $2.46 higher than the value for green manuring.

Assuming under exceptional conditions a yield of only 5 quarts of milk, sold at 1½ cents per quart, the calculated feeding value would be $11.69. Under these exceptionally unfavorable conditions the serradella would appear to be used to slightly better advantage when fed than when ploughed under. In view of these facts, the practice of using serradella for a green manure, instead of feeding the crop, cannot be justified and must be regarded as bad farm management.

The claim is frequently made, in advocating the growing of serradella for green manuring, that it is an exceedingly cheap means of securing nitrogen; that with a small expenditure for seed, and no extra labor except that of sowing the seed, a large amount of nitrogen is secured from the air. Admitting this, has not this ni-

trogen, in the form in which it exists, namely, as protein and amides, a much higher value when used for feeding animals than when ploughed under? If it is the cheapest source of nitrogen for manuring, is it not also the *cheapest source of protein for feeding*, especially when six-sevenths of the nitrogen in the crop is recovered in the manure? In the daily ration of 120 pounds of green serradella are 3.6 pounds of protein, equivalent to 0.576 pound of nitrogen. With an average production of 7½ quarts of milk per day, 0.492 pound of this nitrogen passes into the manure, while only 0.84 pound, or about one-seventh, goes into the milk. By using the crop as fodder, animal production is aided and still only a very small portion of the nitrogen is used; by far the larger portion goes into the barnyard manure and is applied to the soil.

Beyond question, then, the nitrogen of the air, which is obtained without cost through the agency of leguminous plants, is best utilized in improving the productiveness of the land and increasing the profits when it is used in the production of milk and meat, and thereby in the production of cheap barnyard manure. By this method not only the nitrogen, but also the carbohydrates and fats which the plants derive from the carbonic acid of the air are made use of. For these latter substances also serve to nourish the animal and build up new material, and a portion, in turn, passes into the barnyard manure and has a favorable effect on the humus formation. This is the true economy of material. The pecuniary advantage from feeding the crop will be correspondingly higher, the higher the prevailing price of hay and feeding stuffs in general.

What has been said in regard to serradella applies equally well to the sand vetch, which belongs to the same order of plants as serradella (*Papilionaceæ*). It is grown in the stubble of winter grains and with especially good results with winter rye, furnishing a green fodder for spring. It is of exceptional value for sandy soils and furnishes an excellent fodder for milch cows. But to use it for green manuring, as is often recommended, would be a waste of valuable food material and exceedingly bad practice.

Several non-leguminous plants are also worthy of notice as catch crops for sandy soils. Among these are spurry, buckwheat, and field turnips. Although these plants are not believed to derive nitrogen from the air in any considerable amount, they develop well in the stubble of winter rye when not sown too late, and furnish valuable green fodder. They have also been recommended for green manuring, but are of far greater value for feeding purposes.

Green manuring on medium rich soils has much less to recom-

mend it than on sandy soils. Although the green manuring of light sandy soils with lupine is often of very great advantage in enriching the soil in humus, this advantage does not hold good in the case of better soils. Lupine grows well on the latter, but is not profitable enough to be used as a principal crop, and is not well fitted for a fallow crop, since the rye ripens somewhat later on heavier soils and does not leave time for a sufficient development of the catch crop. Furthermore, the widespread practice of growing clovers and lucern on all soils of the better classes assures a good supply of humus-forming material from the elaborate root system of these plants. While it is desirable on these soils, as well as on lighter soils, to encourage the humus formation with the stubble and roots of fallow crops, a green manuring to this end cannot be justified.

There are other plants better adapted than lupine to serve as fallow crops on these better soils. Serradella does well, but as a rule is not to be recommended for a principal crop, and when sown with rye, giving a good yield, it is often so choked out as to amount to very little. But where it can be grown with advantage as a first crop on better soils it must be fed to be utilized to the fullest extent, as pointed out above.

The kidney vetch is not to be recommended as a catch crop. For autumn use the crop is much too small, but in the following spring it gives an unusually rich and profitable crop of hay, amounting to 2½ tons per acre, and even more. The same applies to scarlet clover. Yellow clover or hop clover would be better fitted for a fallow crop, but here again the crop is more valuable for feeding than for green manuring. The sweet clover or Bokhara clover is said to grow in places where no other forage plant will grow, and is sometimes used for sheep pastures; but for better soils it is ill fitted to compete with other forage plants, as in spite of its luxurious growth it gives too small a crop to be of account either for green manuring or feeding.

Peas, vetch and white mustard are especially adapted for fallow crops, and can all be recommended for green manuring. But as they are also good fodder plants, all that has been said above regarding this subject applies to them with equal force.

An experiment of interest in this connection was made at the Agricultural Institute at Halle in 1891. A piece of land was used comprising about 6½ acres, which had been used for winter wheat in 1890, manured with 35 pounds of soluble phosphoric acid and 132 pounds of nitrate of soda; and for winter rye in 1891, receiving a dressing of nitrate of soda at the rate of 88 pounds per acre. This was divided into two parts, separated by a strip of land. On

the first plat a mixture of 194 pounds of white field peas, 44 pounds of common sand vetch, and 35 pounds of yellow lupine seed per acre was sown August 11; and on the other, 22 pounds of white mustard seed per acre, August 13. The dividing strip remained bare. The crops on both plats were ploughed under October 28. They had made good growth and were fitted either for feeding or green manuring. Generous samples of each crop, representing definite areas, were saved for analysis.

The mixture of peas, vetch and lupine yielded at the rate of 8,650 pounds of green material per acre, which contained, on an average, 0.575 per cent of nitrogen. This was equivalent to 49.74 pounds of nitrogen per acre, which at 15 cents per pound gave a value for the green crop for green manuring of $7.46 per acre. The mustard crop amounted to 12,580 pounds of green material per acre. This contained 0.4248 per cent of nitrogen, or 53.44 pounds of nitrogen per acre, which at 15 cents per pound would be worth $8.02. The calculated money value of the green manuring per acre was, therefore, $7.46 for the mixture of peas, vetch and lupine, and $8.02 for the mustard.

In the spring of 1892, white pearl barley was sown on the whole area, including the dividing strip, at the rate of 2½ bushels of seed per acre. In the early part of the season the crop on the mustard plat was slightly less thrifty and the plants were not quite as green as those on the dividing strip, but the differences were only slight. The crops were harvested August 18 with the following results per acre: —

Yield of Barley Per Acre on Different Plats.

	Grain. Bushels.	Chaff. Pounds.	Straw. Pounds.
Plat green manured with peas, vetch and lupine,	61.38	366	3,260
Plat not green manured,	61.48	385	2,908
Plat green manured with mustard,	61.38	431	2,976

An effect of the green manuring is only noticeable in the amount of straw, which is larger by about 350 pounds per acre where the mixture of peas, vetch and lupine had been ploughed in. The following shows the difference in percentage of nitrogen in the crops:

Percentage of Nitrogen in Grain, Chaff, and Straw from Different Plats.

	Grain.	Chaff.	Straw.
Green manured with leguminous plants, .	1.81	0.51	0.41
Without green manuring, ...	1.52	0.48	0.34
Green manured with mustard, . . .	1.24	0.48	0.31

From the above analyses and yields, the total amounts of nitrogen contained in the three crops per acre are calculated as follows: —

Amount of Nitrogen contained in Crops of Barley Per Acre.

	Pounds.
Plat green manured with peas, vetch and lupine, .	68.56
Plat without green manuring, ...	56.60
Plat green manured with mustard, ...	47.91

It is interesting to notice that while the mustard crop ploughed in contained more nitrogen than the mixture of leguminous crops (53.44 pounds as compared with 49.74 pounds per acre), the crop of barley following the mustard contained less nitrogen than that following the leguminous green manuring. In other words, the barley crop on the leguminous plat contained nearly 19 pounds more nitrogen than had been ploughed in, while that from the mustard plat contained 3½ pounds less nitrogen than had been ploughed under, and nearly 9 pounds less than the strip which had not been green manured.

It would appear that the nitrogen in the soil was rendered less available to the barley by being incorporated into the mustard plants and then returned to the soil in green manuring, and that it must pass through a change before it again became assimilable to plants. The barley did not do as well on this plat at the start, but as the green manure decomposed it made satisfactory growth. The difference between the total yield of nitrogen in the crop from the leguminous plat and that from the strip not green manured, 11.96 pounds, is nearly all accounted for by the 10.86 pounds of nitrogen contained in the leguminous seed sown on that plat for the green manuring.

While too sweeping conclusions are not justifiable from this single experiment, the indications are that on a medium rich soil, green manuring may be wholly without effect on the crop following it.

The peas and vetch plants produced root tubercles, and it is probable that had the plants been allowed to fully develop and ripen, the effect of the tubercles would have been much more apparent in the amount of nitrogen in the crop ploughed under. It is incorrect to assume, as is often done, that the whole nitrogen supply of leguminous plants is derived from the air; the richer the soil is, the larger the proportion which will be taken from the soil and the less from the air. The assimilation of nitrogen appears to go on best when the soil is deficient in available nitrogen.

Compared with the above green-manuring trial on medium rich soil, the result was quite different in a similar trial in 1891 on a sandy loam soil containing only 2.13 per cent of humus. A piece of land which for many years had received uniform cropping and manuring was divided into two plats of about one-fourth acre each. Rye had been grown on both plats that season. On one plat white field peas were sown in the rye stubble, August 15. The other plat was given the same preparatory treatment, but remained bare. Both plats were ploughed November 2. The peavines had grown to a height of 15 to 18 inches, and a large weighed sample showed that the green crop was at the rate of 3½ tons per acre.

March 23, 1892, barley was sown on both plats. The green-manured plat received no other manuring, but the other plat received an amount of nitrate of soda furnishing 28 pounds of nitrogen per acre. The barley was harvested August 9 with the following result: —

Yield of Barley Per Acre.

	Grain. Bushels.	Chaff. Pounds.	Straw. Pounds.
Green-manured plat	68.35	266	2,830
Nitrate of soda plat	67.02	292	2,930

It will be seen that the yield on the two plats was practically the same. The agreement in percentage of nitrogen is equally striking. The grain from both plats contained 1.47 per cent of nitrogen, the straw from both 0.38 per cent, and the chaff 0.51 and 0.58 per cent. The total nitrogen per acre in the crop from the green-manured plat was 60.34 pounds, and from the nitrate of soda plat 60.12 pounds. The green manuring with 37.33 pounds of nitrogen per acre had given a result equally as good in every

way as an application of 28 pounds of nitrogen per acre in the form of nitrate of soda. But even with this favorable result there was no financial advantage from the green manuring. This furnished 37.33 pounds of nitrogen per acre, which at 15 cents per pound would be worth only $5.60, which would no more than pay for the pea seed used.

Had the crop of pea forage been fed, quite a different result might have been expected. The green pea fodder contained 3.35 per cent of protein, 0.44 per cent of fat, 4.63 per cent of nitrogen-free extract, and 2.51 per cent of fibre. With hay at $14.50 per ton, the pea fodder would have been worth $3.15 per ton, or the crop of 3½ tons per acre, $11. Allowing $2.50 for the cost of feeding, and $5.50 for the cost of seeding, there remains $3 to the credit of the pea-vines when fed.

Again, if we calculate in a similar manner the value for feeding of the mixture of peas, vetch and lupine mentioned in the preceding experiment, the result will be $10.59, or $3.13 per acre more than the calculated value for green manuring. The net feeding value of the mustard would be $15.75 per acre, or $7.73 more than the value for green manuring. These figures bring out the high value of white mustard as a fallow crop, especially on good soils. The cost of the seed is small and the crop grows rapidly in the stubble of winter grains, but it does not possess the ability to assimilate the free nitrogen of the air.

The matter resolves itself into this, that the search for a profitable crop for green manuring the better classes of soils is without avail. The distinction should be borne in mind between green manuring — the ploughing under of green plants — and ploughing under the stubble and remains of a crop. The latter is necessary, and often results in much good to the land. But it is a mistake to plough into the soil for manure a pound of vegetable albuminoids which could be used for making milk or meat.

Green manuring, except with lupine on light sandy soils, marks no progress in farm management. Let us then take advantage of these recent discoveries of agricultural science, not to "manure the soil with atmospheric nitrogen," but to produce and to utilize to the fullest extent the nitrogenous and carbonaceous materials derived from the air by feeding them to farm animals.

PUBLIC DOCUMENT . . . . No. 31.

THIRTY-SECOND ANNUAL REPORT

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

JANUARY, 1895.

BOSTON:
WRIGHT & POTTER PRINTING CO., STATE PRINTERS,
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College Barn.

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MASSACHUSETTS AGRICULTURAL COLLEGE,
AMHERST, Jan. 1, 1895.

To His Excellency FREDERIC T. GREENHALGE.

SIR: — I have the honor herewith to transmit to your Excellency and the Honorable Council the thirty-second annual report of the trustees of the Massachusetts Agricultural College.

I am, very respectfully,
Your obedient servant,

HENRY H. GOODELL,
President.

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ANNUAL REPORT OF THE TRUSTEES

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

His Excellency the Governor and the Honorable Council.

Conformable to the provisions of chapter 101 of the Acts and Resolves of 1894, this report covers the transactions of the period embraced within the first day of October, 1893, and the last day of December, 1894.

The Faculty.

Since making the last report, the shorter two-years course in agriculture and horticulture has been completely organized, with an attendance in the two classes of forty-six. The graduate course, leading to the degree of Master of Science, has been opened with four members, three being in residence and one prosecuting his studies away from the college, but under the direction of its instructors. The establishment of these two new courses, with the increased amount of teaching, has necessitated still further additions to the corps of teachers. Of the twenty whose names appear upon our catalogue, one is honorary professor of agriculture and not actively engaged in teaching, and one is a non-resident lecturer, coming from Northampton during the winter months and giving to the senior class a course of practical talks on farm law. The others are all on the ground attending to their duties as required by the schedule. The two new instructors appointed during the year are Ralph E. Smith (July, 1894) and Richard S. Lull (January, 1894). The former is a graduate of the college in the last class, and has done excellent work in the departments of botany and modern languages. The latter was graduated at Rutgers

College, N. J., in 1893, and previous to his acceptance of the position offered him here as assistant in the chair of zoölogy was in the employ of the department of agriculture as special agent scientific field corps, division of entomology. During his year's service he has devoted himself energetically to the care and rearrangement of the museum. Individual specimens have been carefully examined with a view to their better preservation or replacement when found necessary, and the entire collection has been arranged in *natural* sequence to facilitate its study intelligently without a guide. Realizing the invaluable aid of the museum in the teaching of zoölogy, he has prepared a synoptical case as an index to the rest of the room. The good effects of this systematic arrangement is shown in the increased interest and attention paid to the study of zoölogy. Already the narrowing space warns us that provision must be made in the early future for the accommodation of the rapidly increasing collections.

Course of Study.

The elective system has shown its value from the very moment of its introduction. The quality of the work has been greatly bettered and the amount has been increased. As soon as practicable, we would recommend having it go into effect still earlier in the course. The chief obstacle thus far met with has arisen from the difficulty of laying out courses which would meet the popular demand. It had been expected that certain sequences of studies would be chosen which might form the basis of arrangement by courses. But results have not justified this expectation, and we find ourselves in as great perplexity as ever. Sixty-two men have already made trial of this system, and of the eleven studies offered to their choice they have succeeded in making twenty-three combinations of groups of three, as follows: —

Nineteen elected agriculture, political economy, veterinary.
One elected agriculture, chemistry, veterinary.
One elected agriculture, chemistry, political economy.
Two elected agriculture, botany, chemistry.
One elected agriculture, horticulture, veterinary.
Two elected agriculture, horticulture, political economy.
One elected agriculture, electricity, mathematics.
Eight elected botany, entomology, German.

One elected botany, chemistry, electricity.
One elected botany, mathematics, German.
One elected botany, political economy, German.
Seven elected chemistry, political economy, veterinary.
Three elected chemistry, political economy, German.
One elected chemistry, electricity, German.
One elected chemistry, mathematics, German.
One elected chemistry, entomology, electricity.
Four elected chemistry, veterinary, German.
One elected veterinary, political economy, electricity.
One elected horticulture, political economy, German.
One elected veterinary, political economy, horticulture.
Two elected political economy, electricity, mathematics.
Two elected political economy, electricity, German.
Two elected forestry, entomology, German.

Or, arranging the studies in the order of their preference, we find that out of sixty-two students —

Forty-two elected political economy.
Thirty-three elected veterinary.
Twenty-seven elected agriculture.
Twenty-three elected German.
Seventeen elected chemistry.
Thirteen elected botany.
Eleven elected entomology.
Seven elected electricity.
Five elected horticulture.
Five elected mathematics.
Two elected forestry.

Political economy, veterinary, agriculture, German, chemistry, botany and entomology appear to be the favorite studies; but the choice of the students does not yet seem to warrant an arrangement in courses.

The dairy school has not yet been opened. Owing to delay in completing the new barn, to which it forms an annex, it was thought advisable to defer its organization for another year, in order that its equipment and arrangement might be completed. From New Jersey comes the first application from a young lady to be enrolled as a student.

The college was highly favored last year in being selected as the institution at which were presented the Rothamsted American lectures for 1893. From November 17 to December 1, Sir Henry Gilbert delivered a most instructive series

of nine lectures on the results of experiments carried on at Rothamsted by Sir John Lawes and himself during the past sixty years. The subjects presented were: the growth of wheat, barley, mixed herbage, roots and various leguminous crops, year after year, on the same land, both with and without manure, for periods varying from five to forty years; the results of various systems of crop rotation; the sources of fat in the animal body, and the feeding of oxen, horses and pigs with definite rations for various kinds of work or meat. The lectures were strikingly illustrated by a series of ninety large wall charts carefully prepared for the occasion.

During the winter, a lecture was delivered by Pres. Henry E. Alvord on the "Lessons to be learned from the dairy tests at the World's Columbian Exposition;" and in the spring, instruction in forestry was inaugurated by a course of lectures given by Dr. B. E. Fernow, chief of the division of forestry at Washington. The series covered a wide range, embracing the following topics: —

1. The battle of the forests; the survival of the fittest.
2. What is forestry?
3. How trees grow.
4. How forests grow.
5. Accretion and its measurement.
6. Timber physics.
7. Sylviculture — artificial afforestation.
8. Sylviculture — natural regeneration.
9. Sylviculture — improvement of the crop.
10. Forest protection and forest exploitation.
11. Forest survey and forest regulation.
12. Forest finance and summary.

These lectures were given to the senior and junior classes, and awakened the deepest interest. It is hoped that permanent provision may be made for their continuance, and for more extended instruction on this most important subject.

The Library.

What tools and stock are to the workman, books are to the professor and student. They are the sources from which they draw material for the preparation of lecture and recitation. To be of the highest utility, these should be available at all hours, and at any minute, for examination and study.

The library now numbers about 16,000 volumes, made up of the best and latest works in the different departments of science. It is used constantly by the students, 4,453 books having been drawn during the past year. It should be open for consultation the entire day, and the utmost freedom granted the investigator in going to the shelves and examining for himself the different works bearing upon the subject in which he is interested. Lack of means has hitherto permitted its use only for a couple of hours in the afternoon and the same in the evening. A permanent librarian should be appointed, whose duty should be not simply to supervise its care and management and provide for its future growth, but above all to aid the students in their different investigations, and put them in the way of acquiring such information as they need. This is the highest, the crowning work of a librarian.

Expenditure of State Appropriations.

The sewage from the college buildings, formerly emptying into the ravine lying directly north, defiled one of the prettiest spots on the whole college grounds, and offered a perpetual menace to good health. It has now been properly cared for and utilized. It is first carried through pipes directly to a flush tank or cistern, where, by means of a Miller's automatic siphon, it is conveyed across the ravine, and there distributed through the soil on the opposite side.

The expenditure of the appropriations for the erection of new barns, purchase of stock and the establishment of an electric plant are so admirably detailed by the professor of agriculture in his report of the farm and farm buildings, submitted elsewhere, that it is unnecessary to enter into further details.

Buildings and Improvements Needed.

The steady increase of students during the past few years, and the seven or eight additional recitations each day, following upon the admission of the two classes in the shorter course, render imperative the making adequate provision for lecture and laboratory work. In the zoölogical department this lack of room has been more seriously felt than in any

other. This very year, more than one-half of the seniors electing entomology were compelled to give up that study for lack of accommodations. Entomology, botany and German are three correlated studies, so closely linked together that to exclude either of the two first is to render the course practically worthless. The eight young men who elected this did not get what they wanted, for they were compelled to forego the study of one of the most important of their three subjects. They have been disappointed, and the college, from the unexpected numbers electing the course, is placed in the unenviable position of advertising instruction which it cannot give. There are in the zoölogical department one recitation room and one laboratory. The first is occupied by classes in anatomy, physiology, zoölogy and veterinary. The last is utilized for practical work in dissection and drawing. Advanced work in entomology requires the constant use of the microscope, and a room where a student can leave his work and his instruments without fear of their being disturbed before he returns. These last conditions cannot obtain in either of the rooms already mentioned. The only available quarters have been at the insectary, where five and at most six students can be accommodated. To provide, then, room for sixteen to twenty additional workers, it is asked that a small appropriation, not to exceed $3,000, be made, to allow the putting up of a two-story addition to the north part of the insectary, conformable to the plans herewith submitted. The lower story, thirty-two by thirty-six feet, will contain stands and appliances for sixteen students. The upper story will contain a photographing room, and, for special work, two private laboratories, which can, however, be utilized in case of necessity. It is believed that this is the most economical and advantageous arrangement that can be made. It brings the laboratory into direct communication with the insectary, and saves the necessity of putting up a separate building.

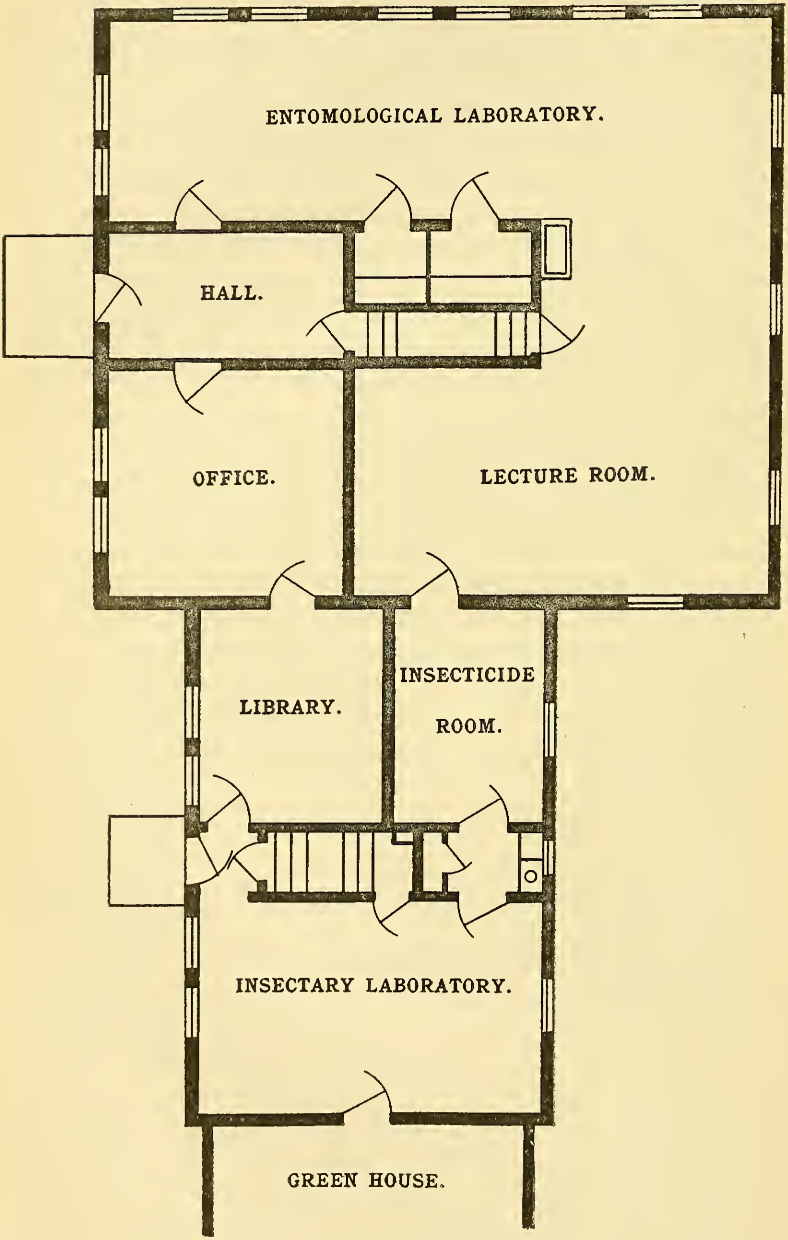
In the recent issue of arms and equipments, two of the new breech-loading steel guns have been ordered sent to the college. Coupled with this is the condition that suitable shelter shall be provided for them. The old quarters, namely, the armory, is not large enough to contain them, and an ap-

propriation, not to exceed $1,800 is therefore asked for the following purpose, to wit: to erect a gun-room twenty-eight by sixty feet, which shall contain, besides shelter for the cannon, a shooting gallery for practice during the winter months; and to build a small gallery at the south end of the drill hall, for the accommodation of the numerous spectators and the prevention of annoyance to those drilling on the floor below.

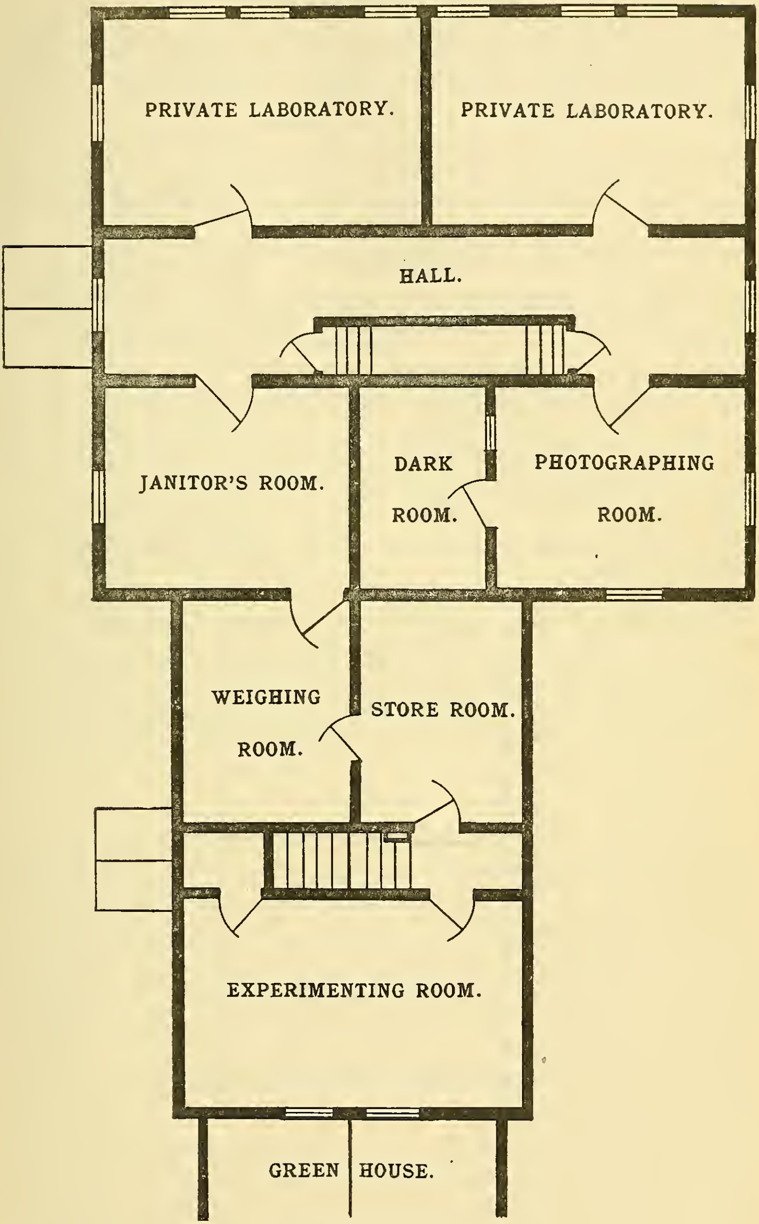
The library of the college belongs to every department, and is used alike by professor and student. It is the right arm of the instructor and the most important factor in the education of the pupil. There is no one thing which conduces so powerfully to the intellectual growth and activity of a college as the general, intelligent use of its library. To bring it to its highest state of efficiency, it must be kept abreast of the mental development of the age, and garner in the harvest of fresh thought and discovery from every quarter of the globe. Fresh solutions of old problems awaken renewed interest, and the dullest mind grows brighter by contact with the minds of other men. The library is deficient in certain sets of periodicals and reference books of science in several of its departments. To supply this deficiency, particularly with reference to plant and animal diseases, it is asked that the small sum of $700 be appropriated.

To recapitulate briefly, it is asked that there be appropriated —

For the erection of an entomological laboratory, ...	$3,000
For the erection of a gun-house with practice gallery and the construction of a gallery in the drill hall, ...	1,800
For the purchase of books, ...	700
	$5,500


ENTOMOLOGICAL LABORATORY.
HALL.
OFFICE.
LECTURE ROOM.
LIBRARY.
INSECTICIDE
ROOM.
INSECTARY LABORATORY.
GREEN HOUSE.

LOWER FLOOR.



SECOND FLOOR.

Experiment Department.

Four bulletins have been issued the past year, in editions of 12,000, 12,500, 13,000, 15,000. The subjects treated were the following: —

No. 24. — Insecticides, particularly the arsenates of lead and soda; the horn-fly, with description and remedies against its attacks.

No. 25. — Formulæ for the preparation of insecticides and fungicides, with directions as to the time and manner of their use; report on one hundred and twenty-one varieties of grapes fruiting in 1893.

No. 26. — Report on small fruits tested during the season of 1894, namely, one hundred and twenty-four varieties of strawberries, twelve varieties of blackberries, eighteen varieties of red raspberries, twenty varieties of black-cap raspberries.

No. 27. — History of the college herd and record of the tests made with tuberculin; outbreak of bovine rabies; poisoning from nitrate of soda.

Twelve monthly bulletins have been issued, in editions of four hundred, in which the record of the meteorological observations for each day has been noted. Owing to shrinkage in the timbers and consequent settling of the floor, it has been found impossible up to the present date to use the electrograph.

The above, however, indicates but a small part of the work done at the station during the year. Great attention has been paid to the gypsy moth and the various pests of the cranberry, and the resources of the entomological division have been taxed to the utmost in furnishing reply to inquiries of how best to repel the invasions of the army, canker and boll worms and other devastating foes. The study of plant diseases has gone steadily on, and the mounting and card cataloguing of some four thousand species of fungi has been commenced. An interesting experiment, the full details of which will be found in the report of the horticulturist, was conducted for the purpose of demonstrating the ability to utilize by evaporation and bleaching the immense quantities of fruit now allowed to go to waste. Six model poultry houses have been constructed, and investiga-

tions into some of the problems of poultry raising have been undertaken. A full index to the subject matter contained in the twenty-seven quarterly bulletins issued by the station and its seven annual reports has been prepared, and will form the twenty-eighth of the series.

The following gifts to the agricultural division of the station have been received: —

From Nitrate Syndicate of South America, two sacks nitrate of soda.

German Potash Syndicate of New York, one ton of kainit and ten sacks potash salts.

W. Atlee Burpee of Philadelphia, Penn., seed of New Danish Island oat, and seed of New Danish improved sugar beet.

E. L. Boardman of Sheffield, seed of naked black barley.

A. F. Hunter of South Natick, three settings of light Brahma eggs.

E. F. Hodgson of Dover, one "Peep-o-day" drinking fountain.

Northrup Braslan Goodwin Company of Minneapolis, Minn., seed of Northrup, Braslan Goodwin Company's Petigree blue stem wheat, negro wonder oat, Minnesota king corn, early mastodon corn, early yellow Huron corn, hog millet, golden wonder millet.

The Entomological Division.

During the past season careful studies have been made and experiments performed on *Orthezia insignis*, the new plant-house pest mentioned in my report of last year.*

Bulletin No. 24 was prepared by this division, and contains descriptions of the horn-fly in its different stages, and also its habits and the best methods of controlling it. This bulletin also contains the results of experiments with four different insecticides.

Much time has been devoted both by my assistants and myself to experiments on the gypsy moth, and to studying its habits for the purpose of discovering cheaper and more successful methods for its destruction.

Numerous experiments have been made with insecticides on greenhouse insects, with varying results. These will be reported in a bulletin at some future time.

The work on the biological collection has been continued, and the card catalogue of the literature of insects has been copied so

* The results of these studies are published in the Appendix of this report.

far as to include the Coleoptera, Lepidoptera, Hemiptera and Orthoptera, which are now represented by 25,000 cards. The other orders of insects are still to be copied from the thin slips upon which they were first written. This catalogue is of very great assistance in our work, and saves a vast amount of time in looking up the literature of any insect.

Many letters have been received from different parts of the State about the depredations of certain common insects, of which the most important are the army-worm, the canker-worm, the boll-worm, the Vanessa butterfly, the red-humped caterpillar, the vagabond crambus, the raspberry-cane girdler and the wrinkled scolytus. Information concerning these insects and what can be done to hold them in check will be given later in a bulletin.

The studies on cranberry insects have been continued, and several insects discovered injuring cranberries, which had not previously been known to feed upon this plant.

The common span-worm of the Cape Cod bogs has been bred, and proves to be *Ematurga faxonii* Minot. I had long suspected that this insect fed on the cranberry, as the moths were found in abundance on bogs infested with the span-worm.

Noctua c-nigrum Linn. was found quite abundant on many bogs. They remained, during the day, concealed in the sand and fallen leaves, and fed by night on the leaves at the tips of the runners, and on the berries, eating out the whole inside through a large hole in one side. Many of the cranberry growers had supposed this to be the work of span-worms.

The red-striped span-worm was found on several of the bogs feeding on the leaves. This larva is about three-fourths of an inch in length, with the dorsal surface yellowish, ornamented with a longitudinal reddish band with short, oblique branches extending from it, and sprinkled with fine white dots. A lateral red stripe occurs on the first few segments of the body. These span-worms were sent to the insectary, where the moths emerged August 11, and proved to be *Eupithecia implicata* Walk.

The green span-worm was found on several bogs, where it was said to be very injurious. Specimens sent to the insectary died on the way, and therefore they have not been bred. *Thamnonoma argillacearia* has been taken flying on the bogs, in such numbers and under such circumstances as to lead me to suspect that it is the moth of the green span-worm. *Thamnonoma sulfuraria* has also been taken flying over bogs under such circumstances as to lead to the suspicion that it may also be a cranberry insect.

Crambus topiarius has been bred by Mr. S. H. Scudder, as a girdle-worm; and while I have for a long time been convinced

that this was the case with this insect, I should not be at all surprised if other species of *Crambus* should be found to possess the same habits, for I have found *C. girardellus* and *C. agitatellus* flying in considerable numbers about large and clean bogs.

A cut-worm was found to be very common on some of the bogs in North Carver, South Carver and Plymouth, hiding in the sand and dead leaves, near the stems of young plants, during the day, and eating the bark of the stems near the ground, often completely girdling them. These were bred in the insectary, and proved to be *Carneades detersa* Walk.

The larvæ of *Acronycta tritona* Hbn. were found in abundance on one bog, where they devoured the leaves, stripping the vines.

The army-worm (*Leucania unipuncta*) was very destructive on the bogs in several towns on the Cape during the past year, cutting off the new growth. *Dichelia sulfureana* was very abundant on one bog at Pleasant Lake; and the larvæ of the June beetle were said to have injured the roots of the plants on many bogs. *Mamestra picta* Har. was found on several bogs, feeding on cranberry leaves with evident relish. *Sphinx gordius*, *Hyperchirio io*, *Lagoa crispata*, *Agrotis ypsilon* and *Acronycta oblinita* were also found feeding on cranberry leaves. Several other larvæ were also found feeding on the cranberry, but have not yet been determined. A more complete account of these insects will be given in a future bulletin.

The Agricultural Division.

Soil tests upon the co-operative plan agreed upon in convention in Washington in 1889 have been continued. During the past season we have carried out six such experiments, — two upon our own grounds, one with corn and one with grass; and one each in Worcester, Concord, Hadley and Shelburne, with mixed grasses and clover. The general results are exactly in line with those of previous years. The main points indicated are shown below: —

Grass and Clover. — First, nitrate of soda, applied early in spring at the rate of one hundred and sixty pounds per acre, has given a large and profitable increase in the first crop, affecting chiefly the grass in the mixed sward.

Second. — Their application produces little or no increase in the rowen crop; and the indication is, therefore, that to produce a good crop of this, a second application of nitrate of soda should be made after cutting the first crop. This we have not tried.

Third. — The potash influences chiefly the growth of the clover in the mixed sward. On those plats where muriate of potash at the rate of one hundred and sixty pounds per acre has been applied there has always been a large proportion of clover.

Fourth. — Those plats which have received potash, doubtless because this application favors clover, produce comparatively large crops of rowen. This result has been particularly striking.

Fifth. — The phosphoric acid has not produced any very marked results upon the growth either of the grass or clover.

Sixth. — For a mixed crop of grass and clover I believe that an application in early spring, consisting of a mixture containing about the following materials in the quantities named per acre, will generally be found profitable: —

Nitrate of soda, ...	150 pounds.
Tankage or dry fish, ...	100 "
Plain superphosphate, ...	100 "
Ground South Carolina rock phosphate, . .	100 "
Muriate of potash, ...	150 "

Corn. — The soil test with corn as the crop upon our grounds the past season is in many respects the most striking of all we have made with this crop, for this is the sixth season that the acre upon which the crop was grown has been under similar treatment. The crops, beginning with 1889, have been corn, corn, oats, grass, grass and corn. The acre is divided into fourteen plats. Four of these have received neither manure nor fertilizer during the six years. These are plats numbered 3, 6, 9, 12.

The fertilizer treatment of all the plats for each year, from 1889 to 1894 inclusive, and the yield of corn and stover this year, are shown in the table below: —

No.	Applied Yearly since 1889 per Acre.	Stover per Acre, 1894 (Pounds).	Shelled Corn per Acre, 1894 (Bushels).
1	Nitrate of soda, one hundred and sixty pounds, ...	2,860	24
2	Dissolved bone-black, three hundred and twenty pounds, . .	2,300	19.5
3	Nothing, ...	2,280	23
4	Muriate of potash, one hundred and sixty pounds, ...	3,600	44.5
5	Lime, one hundred and sixty pounds, ...	2,500	19.6
6	Nothing, ...	1,780	13.9
7	Farm-yard manure, five cords, ...	3,760	68.4
8	Nitrate of soda, one hundred and sixty pounds, . . Dissolved bone-black, three hundred and twenty pounds, .	1,840	22.3
9	Nothing, ...	2,250	21.2
10	Nitrate of soda, one hundred and sixty pounds, . Muriate of potash, one hundred and sixty pounds, . . .	4,100	47.6
11	Dissolved bone-black, three hundred and twenty pounds, Muriate of potash, one hundred and sixty pounds, . .	3,820	52.8
12	Nothing, ...	1,620	17.9
13	Land plaster, one hundred and sixty pounds, ...	2,740	25.3
14	Nitrate of soda, one hundred and sixty pounds, . . Dissolved bone-black, three hundred and twenty pounds, Muriate of potash, one hundred and sixty pounds, . .	3,780	64.4

It will be noticed that wherever potash was used there was a good crop both of stover and corn, but that in no case was there a good crop where it was not used except on farm-yard manure. It is not believed that the phosphoric acid and nitrogen supplied respectively by the bone-black and nitrate of soda should be entirely left out of fertilizer for corn; but it is thought that they should be less prominent than is usually the case.

The results of experiments in other parts of the State are generally similar to those obtained here. The average increase in the corn crop in twenty-six widely scattered experiments, extending over the years 1889 to 1892, due to the different elements of plant food applied at the rates shown in the above table, has been as follows: —

Increase due to nitrogen,	Stover,	376.6 pounds.
	Grain,	5.2 bushels.
Increase due to phosphoric acid,	Stover,	196.3 pounds.
	Grain,	2.4 bushels.
Increase due to potash,	Stover,	1,027.9 pounds.
	Grain,	9.0 bushels.

In view of the general nature of our results, I suggest as likely to prove satisfactory the use for an acre of corn of materials which will furnish: nitrogen, twenty-six pounds; phosphoric acid, forty pounds; potash, ninety pounds. Many combinations of materials may be made which will supply those elements. As one likely to prove generally useful, I suggest: —

Nitrate of soda,	50	pounds.
Dried blood,	100	"
Dry fish,	125	"
Plain superphosphate,	200	"
Muriate of potash,	190	"

These materials should be mixed just previous to application, as they are likely to cake if kept. Where fields are managed under a rotation system, into which clover and grass sometimes enter, the amounts named above will be likely to give good crops; but, as intensive culture usually pays best, my practice, as will be seen by my farm report in another part of this volume, is generally to use larger amounts in the expectation of higher yields.

The trial of *manure alone versus manure and potash for corn* has been continued upon the same acre of land, the past being the fourth successive year of similar treatment. Where manure alone was used, we applied at the rate of six cords per acre, spread after ploughing and harrowing in. The manure and potash, similarly applied, have been put on at the rate of four cords of the former

and one hundred and twenty-five pounds of muriate of potash for the latter. The plats, four in number, contain one-quarter of an acre each. The results are shown below: —

Plat No. 1, manure, stover, 902 pounds; grain on ear, 972 pounds.

Plat No. 2, manure and potash, stover, 965 pounds; grain on ear, 842 pounds.

Plat No. 3, manure, stover, 952 pounds; grain on ear, 1,100 pounds.

Plat No. 4, manure and potash, stover 1,002 pounds; grain on ear, 1,186 pounds.

These figures make it evident that the combination of manure and potash is practically equal in value to the larger quantity of manure alone. On the two plats receiving manure and potash we have 113 pounds more stover and 44 pounds less grain on the ear. The gain in stover at $8 per ton is worth $0.45; the loss in grain at 55 cents per bushel is worth $0.30. The manure applied per plat where used alone must be charged at $7.50; the manure and potash applied to the other plats at $5.68. The advantage clearly lies with the combined manure and potash. On two plats the difference in the cost of application in favor of the manure and potash amounts to $3.64.

Special corn fertilizer has been further compared upon one acre, the past having been the fourth successive season of such comparison with fertilizer richer in potash. There are four plats of one-quarter of an acre each. The yields are shown below: —

Plat 1, special fertilizer, stover, 762 pounds; grain on ear, 919 pounds

Plat 2, fertilizer, richer in potash, stover, 789 pounds; grain on ear, 854 pounds.

Plat 3, special fertilizer, stover, 752 pounds; grain on ear, 935 pounds.

Plat 4, fertilizer, richer in potash, stover, 862 pounds; grain on ear, 978 pounds.

The fertilizer denominated "special" furnishes the amounts of nitrogen, phosphoric acid and potash that would be supplied by the application of 1,200 pounds of a special commercial corn fertilizer of the average composition of all leading kinds offered in our markets. The materials used are shown below: —

	Plats 1 and 3 (Pounds).	Plats 2 and 4 (Pounds).
Nitrate of soda,	55½	33
Dissolved bone-black,	213	112½
Muriate of potash,	27	75

It will be noticed that the crops are nearly equal. The fertilizer richer in potash gives 137 pounds more stover and 22 pounds less grain on the ear than the special. The financial advantage is with the former, for the application per plat costs $63 less, while the crop on two plats is worth $0.40 more, making a net gain on an acre amounting to $3.32.

White mustard as a crop for nitrogen conservation has been under trial upon one acre of corn. The seed is sown in the standing corn early in August, and the mustard generally grows until about the middle of November. It is then generally ploughed in. The present is the third successive year of this trial upon the same field. There is not as yet any considerable difference in crops that is clearly attributable to the green manuring. The yield of stover is this year somewhat larger upon the green manured portion of the acre; that of corn slightly less. The figures per acre follow: —

Not green manured, stover, 3,748 pounds; shelled corn, 55 bushels.
Green manured, stover, 3,894 pounds; shelled corn, 54.4 bushels.

Sulphate of potash has been compared for the third season with muriate of potash for potatoes. The results, as in previous years, have been in favor of the sulphate. It has on the average given the largest crop and tubers of the best eating quality. In this experiment one acre of land was used. It was divided into four plats, suitably separated by strips of land which were unfertilized. To all the plats materials furnishing equal amounts of nitrogen and phosphoric acid were applied. On two plats the source of the potash applied was the muriate, on the other the high-grade sulphate; equal amounts of actual potash to each. On two plats — one sulphate and one muriate — all the fertilizers were put on broadcast after ploughing; on the other two they were all put in the drill.

The yields were at the following rates per acre: —

Sulphate of Potash.

Broadcast: merchantable tubers, 248 bushels; small tubers, 20 bushels.
Drill: merchantable tubers, 268.4 bushels; small tubers, 19.3 bushels.

Muriate of Potash.

Broadcast: merchantable tubers, 254 bushels; small tubers, 16.4 bushels.
Drill: merchantable tubers, 186.4 bushels; small tubers, 11.3 bushels.

It is believed that something other than the difference in fertilizer applied, injuriously influenced the last plat.

In 1893 there was no appreciable difference in the eating quality of the potatoes raised respectively upon sulphate and muriate of potash. Samples of tubers of even size from each of the four plats were, however, subjected to proximate analysis, with the following results: —

Sulphate of potash, broadcast: water, 75.56 per cent; starch, 16.98 per cent.

Sulphate of potash, drill: water 74.40 per cent; starch, 18.44 per cent.

Muriate of potash, broadcast: water, 81.99 per cent; starch, 12.52 per cent.

Muriate of potash, drill: water, 78.98 per cent; starch, 14.11 per cent.

These results, it will be seen, show an average difference of about four per cent more starch in the potatoes raised upon the sulphate. They also show a somewhat better quality as the result of drill application of the fertilizers, — an average difference of about one and one-half per cent more starch.

Japanese Millets. — The three species *Panicum crus-galli*, *miliaceum* and *italicum* have all been under further trial for green fodder and for seed crops. The first proves the most valuable. It has now been tried by a large number of farmers in various parts of the State, and almost without exception is reported upon favorably. Many speak of it in terms of highest praise, and the demand for seed — chiefly from those who have tried it — far exceeds the supply. I still look upon it as rather coarse for hay, but for feeding green or for the silo it has superior merits. It gives yields of from ten to fifteen tons per acre of green fodder. The analyses made show the nutritive value to be very nearly the same as that of corn fodder. Yields of from three to nearly six tons of well-dried hay per acre have been obtained.

The silage made from it is of superior quality. It is comparatively free from acid, and is greedily eaten by cattle. In alternate layers with soya beans it has given very satisfactory results. For comparison with other corn silage, I give the two following analyses: —

	American Average of Corn Silage* (per Cent.).	Millet and Soya Bean Silage (per Cent.).
Moisture,	79.1	77.41
Dry matter,	20.9	22.59
Analysis of Dry Matter.		
Crude ash,	6.6	8.91
Crude protein,	8.0	11.25
Crude cellulose,	28.6	33.14
Crude fat,	3.8	3.71
Nitrogen-free extract,	53.0	42.99

* Jenkins and Winton.

It will be noted that the millet and soya bean silage is considerably richer than the corn silage in protein, which is the most valuable portion of a fodder, — the nitrogenous portion. The seed of this millet, *Panicum crus-galli*, is difficult to save on account of the fondness of birds for it. It yields largely, but there is much unavoidable loss.

Of the other millets, I have to report that the *Panicum miliaceum* will not probably prove valuable for fodder. Its seed is large and nutritious, excellent for cage birds or poultry. The *Panicum italicum* is somewhat like German millet, though in important respects it differs from that sort. In usefulness it will be found about equal to the German, but it must not be sown too thickly.

Soya Beans. — We have continued to experiment with a number of varieties of this crop. We find three of value, and these we call "Early White," "Medium Green" and "Medium Black." The seed of all was originally brought from Japan. The first is the most reliable for seed production in this vicinity, though neither of the others has failed to ripen every season during the last six years. The "Medium Green" appears to be the most valuable for ensilage. This has given a yield of rather over eight tons per acre when ready for the silo.

Sulphate has been compared with the muriate of potash for this crop, and the results are largely in favor of the former.

Different distances between the rows were tried the past season, viz., thirty, twenty-seven and twenty-four inches. The first distance has almost without exception given the most satisfactory crops.

Pot experiments in the culture of three varieties of the soya bean, employing for each, soil from our own grounds and soil from

a locality where this crop had never been grown, were carried out in 1893. The pots were variously fertilized in two parallel series for each kind of soil. To the soil of every pot in one series for each kind of soil a little dust from the floor where soya beans had been threshed was added. The object aimed at was to determine whether the addition of this dust, which, it was known, must contain in abundance the germs of the tubercle bacillus peculiar to soya bean roots, — the bacillus which gives the plant the power to fix atmospheric nitrogen, — would affect the development of root tubercles and the growth and yield of the plants. The results were striking. From a very early stage the plants in the pots to which a pinch of the dust from the threshing floor had been added were of a markedly greener color and more vigorous. The weight of both vine and seed from such pots was larger. Upon examination after harvest the roots were found to have a far greater number of tubercles. The important point here is, that the tubercle development is coincident with greater vigor.

Out-of-door experiments of a similar nature upon a large scale have been tried in the field this year. Upon one-half of a number of areas similarly fertilized throughout, a small quantity of earth from a field where soya beans had been cultivated for several years was scattered; the result in every instance was a marked increase in crop.

Soya beans, as well as other leguminous crops, sometimes fail to assimilate atmospheric nitrogen to any great extent when first cultivated in a neighborhood. This is frequently, no doubt, because the appropriate tubercle bacilli are not present in sufficient numbers. They will usually increase from year to year, and when they become abundant, success will be more certain. It may sometimes pay to import a small quantity of earth from a locality where the crop does well, for the purpose of securing a supply of the needed bacilli.

A considerable number of miscellaneous crops have been under trial upon a small scale. The more important of these are the following: mummy pea, Canada field pea, blue-stem wheat, naked black barley, Japanese naked barley, Japanese barley, Japanese clover, dwarf Essex rape, spurry, flat pea and alfalfa. A few only demanded special mention.

Mummy Pea. — This gave a yield at the rate of $11\frac{7}{8}$ bushels of seed to the acre. I do not consider it superior to the common Canada field pea.

Canada Field Pea. — This gave a yield at the rate of 11 bushels of seed per acre. Our experience indicates that it will pay to raise the seed of this variety to sow for fodder or hay rather than to buy at current prices.

Flat Pea (*Lathyrus sylvestris*). — A supply of seed obtained from Wagner's accredited agents in this country was purchased for a trial upon a large scale. About one-fourth of an acre of light sandy soil was planted; but the seed proved to have been mixed with vetch, and but few plants grew. A second sowing made in June germinated better, but all the plants are yet small. This crop has been very highly praised abroad as a fodder crop of superior merit, and has done well in a few localities in this country. It, however, starts slowly, and requires careful attention at first. As it is perennial, this will not prove an important objection if the plant will do what is claimed for it.

Alfalfa. — About one-fourth acre of light soil has been sown to this crop. It was put in drills about six inches apart, in early spring. It made a good start, and when cut, July 14, it averaged about two feet in height. The weather was then very dry and hot, and the crop was suffering seriously. It was cut about four inches high, in order not to expose the roots to the sun. This treatment apparently has saved it; but it made little further growth. It remains to be seen whether it will endure our winters.

Experiment in warming a Stable for Cows. — The experiment barn belonging to the Hatch station is provided with two wings of similar dimensions and similarly constructed in all respects. One of these is piped for hot-water heating. Our object is to test the question whether the artificial heating of a cow stable will pay. We have made but one test. This began Feb. 13 and closed March 31, 1894. This was rather late in the season for the best results, but financial conditions precluded an earlier beginning. The data obtained are of great interest, but the results are not decisive. There has apparently been a little gain in milk, due to the higher and more equable temperature, but a little loss in cream and fat. These differences are small, however, and may be accidental. We have endeavored to keep the wing which is warmed at about 55° to 60° F. The averages in degrees Fahrenheit are as follows for this stable: —

	First Period.	Second Period.	Third Period.	Fourth Period.
Average of daily maximum,	61.4	63.1	67.5	66.5
Average of daily minimum,	46.4	51.6	55.9	54.1
Similar averages for the cold stable are: —				
Average of daily maximum,	43.6	45.8	57.4	49.3
Average of daily minimum,	24.	21.9	42.8	37.6

Soya Bean Meal compared with Gluten Meal. — In connection with the above experiment, we have tested the relative value of soya bean and gluten meal as a part of a ration for milch cows. The results do not indicate any considerable difference. Cream separation by the Cooley submerged system is more perfect in the milk from cows receiving the bean meal. The line of demarcation is far more distinct, and the cream is thicker and richer in fat.

Poultry Experiments. — A beginning in poultry experiments has been made. For this work six similar houses have been substantially erected. Each includes a room twelve by ten feet, with two windows; and another eight by ten feet, with folding doors the full width on the south. These doors are open in all weather when storms do not beat in, and this room serves as a scratching shed. Connected with these houses are large yards. We have also provided a number of smaller movable houses and coops for colonizing families of chickens about our grounds. Our start was made with purchased eggs of the light brahma and barred Plymouth Rock breeds brought from a distance. The hatch, whether with incubator or hens, was comparatively poor. We have, however, raised pullets enough to stock four of our houses; and experiments in different methods of feeding for eggs are now in progress.

The most important point indicated by our work thus far is the superiority, even in inexperienced hands, of the brooder over the natural mother as a means of raising chickens upon a large scale.

The Horticultural Division.

The work of this division has the past year been prosecuted on lines similar to those of former seasons.

Among the most important subjects taken up has been that of testing new varieties of fruits, vegetables and flowers. A few of the more striking results obtained we will briefly outline in this annual report.

New varieties of the large fruits are obtained by planting young trees and by means of scions or buds which are inserted into bearing trees to hasten the time of fruiting. Large numbers of new varieties have been added to our list, but nothing can be reported as to their merits for many years.

The results from the tests of *small fruits* have been quite satisfactory, and many of these have been already reported in recent bulletins.

Of the varieties of both large and small fruits that show decided merit are the following: —

Apples.

Titkova (*Russian*). — This variety has borne but little the past season, but the fruit is so large and showy, so early and of such fair quality, that if it continues to do well in the east it will be very valuable for early market.

Wealthy. — This new western apple is attracting considerable attention. Nothing can be more beautiful than well-grown specimens. It is medium to large in size, of a brilliant red color on a yellowish ground, and very perfect in form. The flesh is firm in texture, yet juicy and of good quality. It ripens with, or a little later than, the Gravenstein, is very productive, and thus far has proved a remarkable keeper. If it continues to grow in perfection of form and color and is as productive as it now promises, it will prove very valuable as a standard late fall apple for home use and market and for early shipment to Europe.

Ben Davis. — No variety has proved so productive or so long a keeper as this one, and, where quality is not desired, it has proved very profitable. While we would not encourage the growth of varieties of such poor quality, yet its great vigor and productiveness and good keeping properties will cause its more extended growth in New England as they have in some of the more western States.

Peaches.

The promise of a large peach crop was good up to the time of the severe cold weather in April, when the amount of live buds stood at from ten to thirty-five per cent; but very few buds withstood the severe cold that followed. The only varieties that produced fruit of any importance were the Old Mixon, Crosby and the Stump, which yielded about equally a small crop of large, fine fruit; none of the young trees produced fruit.

Plums.

Again the college orchard has produced a large crop of this fine fruit. Among the trees of this orchard are some that are twenty or more years old. By the treatment outlined in Bulletin No. 25 we have had successive crops, and the trees are free from warts. Of the new plums tested, the Japanese varieties are attracting the most attention and certainly promise to give us some valuable additions, but as yet they have not fruited sufficiently to warrant growers in planting them for profit.

Gooseberries.

The growing of this desirable fruit is on the increase as the people learn more of its value, and in the future we may expect a greater demand for it in our markets. By the aid of fungicides, the gooseberry mildew, which has prevented the cultivation of the better European varieties, can be controlled. Many new varieties both of European and American origin have been introduced, but few of them have been fruited enough to enable us to report as to their value.

Strawberries.

Of the hundreds of new varieties planted in plots and field during 1893, none have shown much advance over the standard sorts except possibly the *Marshall.* This variety has the merits of being very vigorous in growth and fairly prolific in runners. It has very large foliage and fruit large and perfect in form, of dark color and good quality. It is also productive, and if it proves free from blight, will be a valuable addition to our home and market varieties.

Insecticides and Fungicides.

In connection with the tests made of all of the new varieties of fruits and the growth of limited areas for market, numerous experiments have been made with insecticides and fungicides, applying them to all of the fruits and such vegetables and flowers as are liable to serious injury from either insect or fungous pests.

The fungicides and insecticides used and the time and methods of application are outlined in Bulletins Nos. 25 and 26, with some of the results. A brief summary of the results obtained and not yet reported for the past season is as follows: —

Apples. — The fruit on sprayed trees was much more free from the larvæ of the codling moth than on the unsprayed ones; the canker worms caused no injury in our orchards, while neighboring orchards that were unsprayed were seriously injured, and no apple scab appeared except on unsprayed trees.

Pears. — The pear tree Psylla appeared early in the season, but by spraying several times on their first appearance with the kerosene emulsion, they were soon all destroyed. On the trees sprayed with the Bordeaux mixture, less blight and cracking of the fruit appeared than upon those unsprayed, although, owing to the dry weather, which is unfavorable to fungous growth, this disease was not as prevalent as is generally the case.

Plums and Cherries. — Serious injury to the trees and fruit of

the plum and cherry is reported where the trees were not sprayed; but in the station orchards little or no injury occurred from the plum curculio, the black wart, the brown fruit-rot or the leaf blight.

Grapes. — Nearly all of the more hardy varieties of grapes were uninjured by any of the prevalent diseases, but a few of the most susceptible were seriously injured on vines that were unsprayed. By spraying, such varieties retain their foliage much longer than when unsprayed, and consequently the wood ripens more perfectly; and such varieties as the Iona and Rogers hybrids gain in vigor and hardiness, instead of growing weaker each year when the mildews and rot are abundant. We feel certain that such varieties, which will keep under proper conditions up to the middle of winter, would be very profitable to the New England grower.

Raspberries and Blackberries. — The *spring* orange rust appeared on several varieties of blackberries and blackcap raspberries, but was soon checked by the use of the Bordeaux mixture. The *fall* orange rust, first noticed in sufficiently large quantities to do serious harm the past season by this station, is being treated, and it is hoped that some remedy can be reported by another season whereby no further injury from it need be feared.

Strawberries. — The leaf blight, to which many of the older varieties are subject, so far as we have made the trial has not been prevented by any of the fungicides, although in some cases marked improvement was shown from the use of the Bordeaux mixture.

Varieties of Fruits.

Of the varieties that are the most profitable for market in Massachusetts or most desirable for home use, we would mention the following in order of time of ripening: —

Apples. — Red Astrachan, Oldenburg, Gravenstein, Wealthy, Twenty Ounce, Fall Pippin, Hubbardston, Rhode Island Greening, Baldwin, Roxbury Russet, Ben Davis.

Pears. — Clapp's, Bartlett, Sheldon, Seckel, Bosc, Anjou, Lawrence and Hovey.

Peaches. — Rivers, Old Mixon, Crawford's Early, Crawford's Late, Crosby and Stump.

Plums. — Bradshaw, Washington, McLaughlin, Lombard, Bavey's Green Gage and Victoria.

Cherries. — May Duke, Governor Wood, Early Richmond, Montmorency, Windsor and Black Tartarian.

Quinces. — Orange and Rea's Mammoth.

Grapes. — Winchell, Worden, Concord, Delaware, Brighton; and we would suggest for trial, on account of their late-keeping

qualities, the Iona, Wilder, Massasoit, Salem, Merrimac, Lindley and Herbert.

Currants. — Fay's Prolific, Cherry, La Versaillaise and White grape.

Gooseberries. — Downing's, Smith's Improved and Industry.

Strawberries. — Bubach, Haverland, Lovett, Marshall and Greenville.

Poplar Rust.

For many years the black poplar (*Populus nigra*) has been seriously injured by the leaf blight or rust, which checked its growth and caused its leaves to fall so early as to seriously disfigure the beauty of the locations where planted. Following this loss of foliage the immature wood of the lower branches has often been destroyed by the following winter's cold, and the trees thus very much weakened. Some results of the use of the Bordeaux mixture were given in Bulletin No. 25, and again the past season we have had much more marked success in its use, the trees holding their foliage several weeks longer than those unsprayed. This tree on account of its rapid growth is very valuable for ornamental purposes and for forest growth, and by the use of the Bordeaux mixture it can be kept in perfectly healthful condition until the leaves turn yellow and fall off from full maturity.

Evaporating Fruit.

The immense apple crop of 1894 has led to much discussion as to the best means of utilizing it. Much of this fruit has been a total loss to the producer, from the fact that with so many fall and early winter varieties the demand in our local markets was not equal to the supply, and this quality of fruit would not keep long enough to make it profitable to ship to distant markets. Of the ordinary early fall apples thousands upon thousands of bushels were either allowed to go to decay or were made into cider, when if they had been taken while still fresh and firm, they could have been made into a product by evaporation that would keep any desirable length of time, and permit of being shipped to the most distant markets of the world.

Investigation of the crop of several orchards the past season shows that in the ordinary average orchard, where a large number of kinds are grown, from one-third to one-half of the fruit has been sold for the manufacture of cider. In orchards of younger trees, where only a few varieties are grown, the percentage of cider apples would be much less; but it would run high unless the trees had been sprayed to protect them from insect attack, or the small and injured fruit had been removed in the process of thin-

ning. It is true that such fruit is more or less defective from various causes; but when pared and cut into slices, as is done by the machines used to prepare it for the evaporator, it is but little work to remove the imperfect parts as it is being spread on the trays.

To test the value of the method of utilizing this almost waste product by evaporation, three evaporators of small capacity and of different makes were purchased, with the most approved paring apparatus, and put in operation about October 20. The fruit used was a little above the ordinary grade of cider apples, but containing very few apples good enough to put in as No. 2 market apples.

Two men were employed, and all the evaporators were kept running at once. The fruit was weighed before paring and after drying also. The product of each evaporator was kept separate, and a careful account kept of the cost of production. In the process of manufacture the apples were pared and cored at one operation; they were then dropped into a slicer, where, by a single stroke, each one was cut into slices from three-sixteenths to one-fourth of an inch thick. These were then dropped into a tub of water to which had been added salt at the rate of one-half pound to about five gallons. They were allowed to stand in this liquid from ten to twenty minutes, when they were placed on the evaporator trays and put into the bleacher. The bleacher is a close box of the size of the trays, with cleats on the inside, and with a little draught at the top to carry off any surplus fumes. A small quantity of sulphur or brimstone is kept burning in this while the fruit is exposed. After remaining in the bleacher from fifteen to twenty minutes, it is transferred to the evaporators. The time that the fruit was kept in the evaporator varied with the amount of fire in the furnace; but in every case an effort was made to keep this up as high as possible without burning the fruit. The liability of burning the product was greatest with the "Stahl," less with the "American" and least with the "Topping."

The results with each evaporator are as follows: —

The "*Topping*" consumed 44 bushels of apples.
producing 272½ pounds of dried fruit.
yielding 6⅕ pounds per bushel.
costing 4.3 cents per pound.

The "*American*" consumed 30 bushels of apples.
producing 194¼ pounds of dried fruit.
yielding 6½ pounds per bushel.
costing 5.3 cents per pound.

The "*Stahl*" consumed 50 bushels of apples.
producing $323\frac{1}{2}$ pounds dried fruit
yielding $6\frac{1}{2}$ pounds per bushel.
costing 5 cents per pound.

The amount of fruit evaporated in a day was far below the guarantee of the manufacturers. This may have been partly due to lack of skill of the manipulators; but we think the results obtained are much nearer what would be secured by the average operator than what are claimed by the manufacturers. The latter assert a capacity of from eight to twelve bushels per day of fifteen hours; but the results of our experiments place their capacity at only four to five bushels per day of ten hours. The capacity of the paring and slicing apparatus was far greater than that of the combined evaporators; and it was found that one man could pare, core and process the fruit after one evaporator was filled as fast as the evaporators combined could care for it. This leads us to the *conclusion that for profit an evaporator of much greater capacity must be used; and that the small evaporators can be of little value except when the operator is engaged in other work, where the short time necessary to fill it and care for the fire would not interfere with that work*, — as, for instance, where women or children are occupied near the evaporator.

Co-operative evaporators of large capacity are built in many places, where large quantities of fruit are put in at once and allowed longer time to cure without the danger of burning, and where sufficient fruit can be worked up to keep pace with the ripening of all varieties. This would seem the most promising method of utilizing this large product which now goes to waste.

The *quality* of the evaporated apples depends upon *three things;* namely, the *quality of the fruit, its state of ripeness and the variety used.* As to the first, it may readily be seen that the larger, fairer and smoother the fruit, the better the quality of the product. In the second case, the results of our experiments show that sound, fresh fruit gives a larger and better product than over-ripe fruit, the yield under these conditions ranging from four to seven pounds per bushel. The quantity and quality of the product also depend upon the variety. The varieties used in the test were as follows, arranged in groups according to the quality of the product: —

Producing the best are the *Swaar*, *Snow*, *Ben Davis*, *Hurlburt*, *Baldwin* and *Willow Twig.*

Producing the next best quality are the *Westfield Seek-no-further*, *Rhode Island Greening* and *Red Russet.*

Producing the poorest product, *Roxbury Russet*, *Northern Spy*, *Minister* and *King*.

The appearance of the fruit coming from the different evaporators was varied, that from the "Topping" being the best, the "American" taking the second rank and the "Stahl" the third.

In considering the healthfulness of the product of these evaporators, objection has been made that the sulphur used in the process of bleaching might render the fruit injurious. To settle the question as to the quantity of sulphur absorbed by the fruit in the process of bleaching, samples from each evaporator were sent to the State station for analysis, with the results as follows: —

The fruit from the "Topping" contained 1-30 of 1 per cent of sulphurous acid.

The fruit from the "American" contained 1-7 of 1 per cent of sulphurous acid.

The fruit from the "Stahl" contained 1-5 of 1 per cent of sulphurous acid.

Even the highest amount found, we are informed by Dr. C. A. Goessmann, is so minute and in such combinations with the fruit as to be *entirely harmless*. Should any, however, object to this small amount of sulphur, which possibly may be detected in the flavor of the fruit, it will be found that it is largely dissolved in the water used for soaking the fruit previous to cooking, and that by pouring off this water nearly all of the sulphur will be removed.

The Meteorological Division.

Besides the general routine work of taking daily observations, reducing data and recording results, work has been done for the purpose of ascertaining the facts about certain meteorological theories. Weather periodicity based upon recurring changes in temperature or electrical phenomena is being investigated. While these theories are still in their infancy, yet encouraging results have been ascertained. The temperature, barometric and precipitation curves, based upon data taken for over fifty years, have been plotted at this station, and show a decided tendency toward periodical recurrences; not only is this true of succeeding years, but also of the months. If these recurring meteorological changes are found to be constant in their appearance, it will be possible to forecast the weather many days in advance. To help solve this problem has been one of the efforts of this division.

Also much data have been recopied and put in a more comprehensible and practical manner for future reference. By special request of the Weather Service at Washington a series of observations have been taken for ascertaining the temperature at which a killing frost is possible, and the temperature at which a frost is possible, as well as the relation between the temperature on the tower and that of the shelter a few feet above the ground. These temperatures are taken with the standard minimum thermometer, exposed in the regulation thermometer shelter. Much study has been made of the weather maps, two of which are received daily, and the local and government forecasts compared with the actual conditions of the weather at this station for the same period. In fact, verifying daily forecasts has been quietly carried on at this station for several years, and we believe no other station has ever continued this work for so long a period. The local and Washington forecasts are carefully studied and marked according to a certain standard which was decided upon at the outset. Although the work has required a large amount of time and patient application, yet the value of energy and time expended is small when compared with the results obtained. The conclusion arrived at, based upon actual observation is, that the efficiency of our weather service, as shown in weather predictions, is certainly gratifying. The average percentage of accuracy of the local service for the whole period is ninety-one per cent and the Washington ninety per cent. While the local service is slightly ahead of the department at Washington, it is due the latter to say that the slight difference in the averages in favor of the Boston office should not alone be considered as indicating superior foresight of the officials at the latter place, as they have a small area to consider in making weather predictions for New England, while the officials at Washington make forecasts for the whole country. The predictions of Foster in St. Louis, based upon electrical and periodical weather changes, which predictions are made two weeks in advance, and those of Clayton at Blue Hill, whose bulletins have been carefully watched, show that these gentlemen also have methods of forecasting the weather which give remarkably good results.

All official telegrams received at the observatory are recorded, the time they are received and the time the weather signals are hoisted, it being thought proper to make a record of this for future reference.

While certain lines of investigation already begun have not been fully completed, yet much careful and thorough work has been accomplished during the year.

Annual Statement of the Hatch Fund, Massachusetts Agricultural College,

For the Year ending June 30, 1894.

By George F. Mills, *Treasurer pro tem.*

Cash received from United States treasurer,		$15,000 00
from agricultural department,		623 37
from chemical department,		65
		$15,624 02
Cash paid for salaries,	$7,221 42	
for labor,	1,441 76	
for freight and express,	112 20	
for printing,	1,238 26	
for incidentals,	1,875 83	
for supplies,	3,295 12	
for barn,	305 00	
for postage,	39 59	
for travelling expenses,	94 84	
		$15,624 02

Amherst, Mass., Oct. 5, 1894.

I, the undersigned, duly appointed auditor, do hereby certify that I have examined the books and accounts of the Hatch Experiment Station of the Massachusetts Agricultural College for the fiscal year ending June 30, 1894; that I have found the books well kept and the accounts correctly classified as above; and that the receipts for the time named are shown to be $15,624.02 and the corresponding disbursements $15,624.02. All of the proper vouchers are on file and have been by me examined and found to be correct, there being no balance to be accounted for in the fiscal year ending June 30, 1894.

CHARLES A. GLEASON, *Auditor.*

Farm Report.

Notwithstanding the almost unprecedented drought of the past season, the operations of the college farm have been attended with a fair measure of success. The rainfall from January 1 to September 1 at this place was but very little more than one-half the average. In spite of this fact, most of our crops were good, although the hay crop — particularly the second growth — was undoubtedly considerably cut down by the dry weather.

The number of acres in the several crops of the year was as follows: hay, 80; potatoes, 16.6; corn, 29.1; oats and peas, 3; millet, 1; rye for fodder, 3; beets, ½; carrots, ½; and turnips, 3 (after oats and peas), — a total of 136.7 acres. The money

value of the products — estimating hay at $12 per ton, corn stover at $8 per ton, corn at 55 cents per bushel, small potatoes at 15 cents per bushel, sweet corn seed at $1 per bushel, potatoes at 50 cents per bushel, beets at $4 per ton, carrots at $10 per ton, rye fodder at $3 per ton and turnips at 15 cents per bushel — amounted to $6,582.05, — an average of $48.15 per acre. Had hay been estimated at the price allowed last year ($16 per ton), the average value per acre would have been $52.05, — little higher than last year.

The several fields and products were as follows : —

Hay. — Old mowings (in front of buildings and not re-seeded for many years), 35 acres : hay, 57 tons, 21 pounds ; rowen, 24 tons, 1,035 pounds. South of new barn, 10 acres : hay, 19 tons, 1,603 pounds ; rowen, 6 tons, 790 pounds. North of target butt, 9 acres : hay, 13 tons, 530 pounds ; rowen, 4 tons, 1,100 pounds. South of horse barn, 4 acres : hay, 5 tons, 242 pounds ; rowen, 2 tons, 1,585 pounds. South flat, 22 acres : hay, 35 tons, 670 pounds ; rowen, 14 tons, 115 pounds.

Potatoes. — West of old barn, 5½ acres : merchantable, 1,419 bushels ; small, 284 bushels. North flat, 6½ acres : merchantable, 1,089 bushels ; small, 117 bushels. West of new barn, 4.6 acres : merchantable, 1,103 bushels ; small, 150 bushels.

Corn. — On Plainville road, 10 acres : shelled corn, 1,062 bushels ; stover, 39 tons, 650 pounds. West of "ravine," 6 acres : shelled corn, 537 bushels ; stover, 20 tons, 275 pounds. Middle flat, 13.1 acres : shelled corn, 668 bushels ; stover, 24 tons, 300 pounds.

Beets. — One acre : 20 tons.

Carrots. — One-half acre : 12 tons.

Oats and Peas. — Two acres : hay, 5 tons, 310 pounds.

Millet. — One acre : hay, 2 tons, 1,875 pounds ; and fodder fed green, estimated at 5 tons.

Turnips. — As second crop, 3 acres : 275 bushels.

The manures and fertilizers applied to the several crops are shown in the following table : —

Application per Acre.

	Old Mowings.	New Mowings, Second Year.	Field Corn.	Corn intended for the Silo.	Potatoes, Old Land.	Potatoes, Newer and Richer Land.	Oats and Peas.	Millet.	Beets and Carrots.
Manure, cords,	4	-	4	4	-	-	-	-	-
Nitrate of soda, pounds,	100	100	100	100	125	125	250	100	150
Plain superphosphate, pounds,	-	-	200	200	400	400	400	200	300
South Carolina rock phosphate, pounds,	-	200	200	300	200	200	400	200	300
Dried blood, pounds,	-	-	-	-	200	-	-	-	-
Tankage, pounds,	-	300	-	-	-	-	-	-	150
Bone meal, pounds,	-	-	-	-	100	100	-	-	100
Muriate of potash, pounds,	-	150	150	125	-	-	300	150	250
Sulphate of potash, pounds,	-	-	-	-	300	300	-	-	-

Newly seeded mowings are not manured the first year. The methods of application of the manures and fertilizers have been in general the same as those described in the last annual report. The object which we are keeping prominently in view is to accumulate in our soils a reserve of phosphoric acid and potash, using for each, materials which furnish these at the least cost per pound. Having now for two years applied ground South Carolina rock phosphate quite liberally to most of our fields, it is believed our soils have been so enriched in phosphoric acid, which nature will render gradually available, that we shall hereafter require but little superphosphate.

We have this season, favored in part by the drought, but largely as the result of more thorough work, kept all our fields far cleaner than ever before. We have closely approached our ideal, — never to allow a weed of any kind to perfect seed in any of our fields.

New Implements. — I desire to speak in especial commendation of the following machines and implements: Leggett's dry insect powder or Paris green gun, the Hoover potato digger, Zephaniah T. Breed's weeder and Prout's horse hoe.

Leggett's gun enables us to apply pure Paris green for the Colorado potato beetle at the rate of from one-half to one pound per acre in an entirely satisfactory manner. One man can easily cover six acres per day. We estimate the saving by its use compared with applying the green mixed with plaster in the old way to amount to from three to four dollars per acre.

The Hoover potato digger, drawn by four horses, will dig about eight acres of potatoes per day in a very satisfactory manner, when the fields are level, smooth and free from weeds. In digging sixteen and six-tenths acres we estimated a saving this year of about ninety dollars as compared with hand digging. The machine can be operated by two heavy horses; but we found four more satisfactory, as we could run the digger deeper, thereby leaving fewer tubers in the ground, and could move slowly and easily. With but two horses the animals are obliged to go "upon the jump."

Breed's weeder and Prout's hoe are better known, and extended remark is unnecessary.

Live Stock.

Horses. — Our horses and colts have been uniformly healthy throughout the year, and we now have the following animals: Percheron, 1 stallion and 2 mares, 2 stallion colts; 2 three-fourths Percheron mares; 1 three-fourths Percheron stallion; 1 half blood Percheron mare, 2 geldings and 2 mares; total, 13.

Cattle. — Previous to the destruction of our old barn by fire, it had been decided not to take cattle from the old barn into the new one, as it was felt that all had, at any rate, been exposed to the contagion of tuberculosis.

It was our plan, decided and entered upon in the fall of 1893, to milk those which appeared healthy as long as profitable, then to subject to the tuberculin test and slaughter; the carcasses of those found upon examination to be sound to be put upon the market as beef, the others buried. About one-half of our herd having been thus disposed of previous to the fire, that event made it seem best to slaughter the balance at once, and after the tuberculin test this was done. The results of the test and examination of the carcasses demonstrated the remarkable accuracy of the tuberculin test for tuberculosis, and showed nearly two-thirds of our stock to have the disease; in about every instance, however, in its very early stages, the tubercles being exceedingly small. All these affected animals when alive had the appearance of health.

It was decided to take as a basis for a new herd high-grade shorthorn heifers and young cows from a locality in the west where the disease tuberculosis has been unknown, and where the animals, from open-air ancestry, had for the most part led an open-air life. It was recognized that these animals would be inferior as dairy individuals to stock from dairy breeds nearer home; but, knowing that tuberculosis has very frequently shown itself among the dairy stock in dairy regions, it was thought best

to take these western animals as a foundation upon which to grade up in dairy lines; and the Shorthorn, rather than either of the distinctively beef breeds, was selected, as the milking character is better developed.

Animals which seemed to meet all requirements, and many of them with good indications of merit as milkers, were found in western South Dakota. They were selected by Dr. James B. Paige and myself, with the assistance of Mr. William J. Sessions of South Dakota, in August last, and were shipped to Amherst in October, arriving in good condition and without accident of any kind. Ten cows and forty heifers, from one and one-half to three years old, were procured. They were subjected to the tuberculin test after their arrival before being put into our barn.

It is the intention to procure one young bull and one heifer of each of the following breeds: Jersey, Guernsey, Ayrshire, Holstein-Friesian, Shorthorn and Aberdeen-Angus. These are to be placed here to represent their respective breeds for educational purposes, and the bulls will be crossed upon the grade Shorthorns above described. The utmost care will be taken in the selection of these animals. Every individual purchased must satisfy the following requirements: first, he must come from a herd where tuberculosis has never been known; second, his ancestry, so far as can be learned, must be free from the disease; third, he must be an animal of great apparent vigor and constitution; and fourth, he must pass the tuberculin test. That we shall endeavor to procure animals of merit in other respects, of course goes without saying.

We shall not be satisfied to put animals thus selected directly into our new barn. Arrangements have been made to keep all such animals purchased, during a probationary period of at least six months, apart from our herd; and during this period we shall have them subjected to the tuberculin test one or more times.

I believe it must be admitted that we are neglecting no precaution which seems likely to prove useful in procuring animals free from tuberculosis, and in keeping them so. We shall endeavor to prevent the expectoration of sputa, by persons having coughs and colds, upon the floors in any part of our barns. We recognize, however, that, since human consumption is so common, we are necessarily under some risk of again having the disease implanted in our herd, even should we succeed, as we hope and believe we may, in starting free from it. Especially should it be recognized that in a public institution of this character, where thousands every year pass through our barns, the risk is greater than it would be in private stables. I would appeal to the visiting public,

therefore, to observe the one simple rule of refraining from expectoration upon floors in the barns or the grounds about them.

Sheep. — Our flock of Southdowns, now numbering twenty-four breeding ewes, eight ewe lambs, one ram and five ram lambs, has enjoyed a high average of health during the year, and the breeding increase has been satisfactory. There has been one incursion of dogs, and one of the best of our ewes was very seriously bitten about the throat. Under the skilful surgical treatment of Dr. Paige she made a good recovery.

It is our purpose to add to our flock specimens of the Shropshire, Merino, horned Dorset and Cotswold or Lincoln breeds for educational purposes.

Swine. — The destruction of our herd of cows left us without skimmed milk for feeding hogs; and, as our new quarters were not ready, all our swine were sold. As soon as we have a supply of skimmed milk, the new pens being now ready, we propose to restock with several of the more prominent breeds.

Improvements. — The forces of the farm have been kept very busy for the greater part of the time which could be spared from the ordinary work of the farm, in grading, road building and general work about our new buildings. During the present calendar year work has been performed in connection therewith, which, charged at current rates, would amount to $2,050.52. Besides this, we have performed a large amount of work upon the new sewage disposal works.

Of the more ordinary farm improvements I have but one of any considerable magnitude to report. We have cleared of stumps about two acres which five years ago was heavily wooded, and have broken up the greater part of the area with the plough. We have also begun clearing that portion of the estate which lies south of the Plainville road, in preparation for converting it into pasture.

Farm Buildings.

The barn which stood near the southern boundary of our estate, familiar to all friends of the college, who had ever been here, as the college barn, was completely destroyed by fire, supposed to have been incendiary in its origin, on the evening of June 9. All the horses, cattle and swine, as well as most of the vehicles, machines and tools, were removed, mostly through the efforts of the students, who showed commendable coolness, presence of mind and efficiency. It was chiefly through their efforts also that the farm-house, which was gravely threatened, was saved. But a

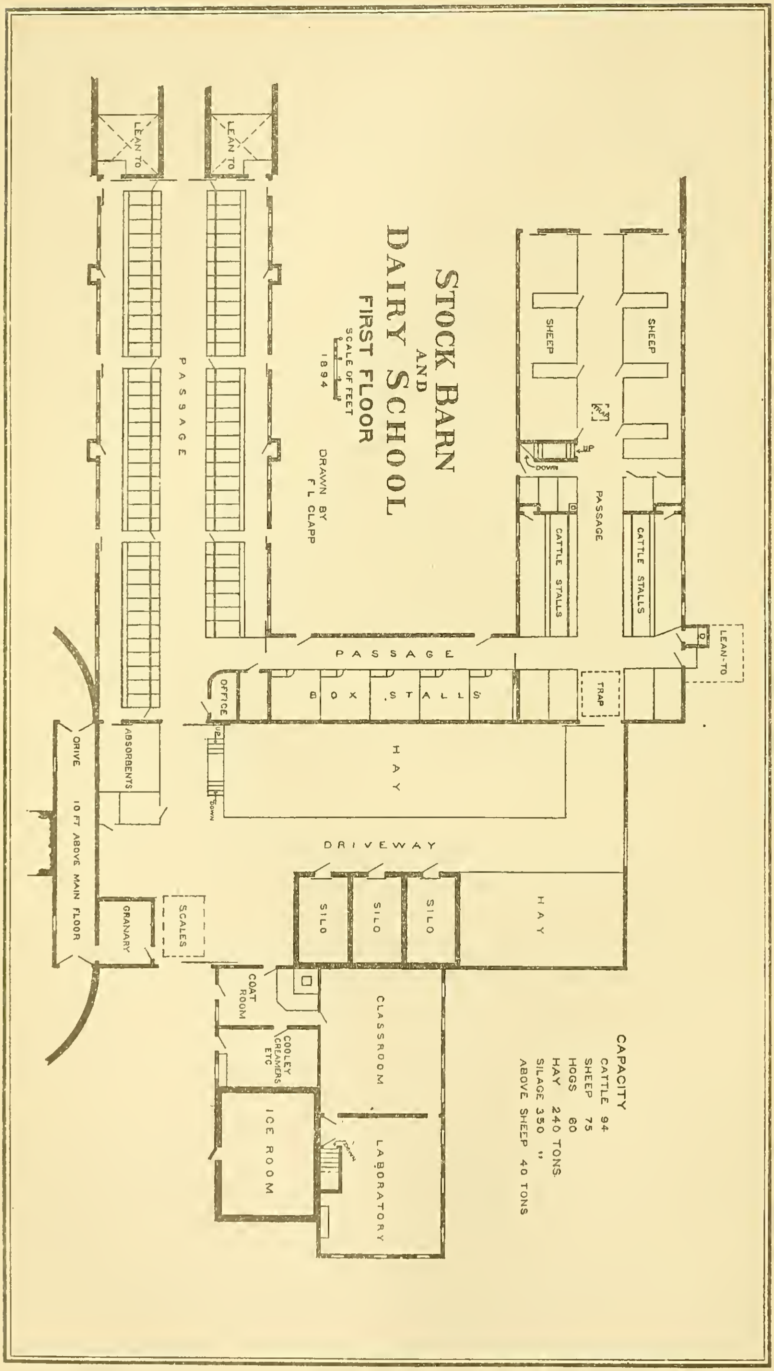
Interior View of Cattle Barn.

small proportion of the loss was covered by insurance. The loss of this building before we could occupy our new barn and stable subjected us for about two months to very great inconvenience. We were, however, ready to put our hay crop into the new barn, and should have done so even had the old barn not been destroyed.

The new set of farm buildings, the erection of which had just been begun when my last report was written, has been completed. Views and plans are included in the present report, and a few words in explanation seem desirable. The location is almost the exact geographical centre of that portion of the college estate which is under the direction of the professor of agriculture. The topographical character of the spot rendered it comparatively easy to secure arrangements permitting the utmost economy in the handling of all materials. Those familiar with our grounds will understand the position of the new barn, when I state that it is just south of the western end of the "ravine." The stable is unconnected with the main barn, standing about one hundred feet east of it, and about ninety feet farther to the east now stands the farm-house, which has been moved from the old location.

The first of the views presented (frontispiece) gives an idea of the appearance of the barn from the campus. Three of its component parts only are shown; viz., the main or storage portion, fronting east; the cow stable, the wing, with monitor roof; and the sheep barn, so called on the plans, which, however, accommodates young cattle and bulls on the same floor with the sheep, and below in the basement has pens for swine, swill room, slaughter room and root cellar. The parts not shown in this view are a lean-to, containing box stables, which lies between the cow stable and the sheep barn; and the dairy school, which is on the northern side of the storage barn. Reference to the main-floor plan (fronting page 45) will make the arrangement clear. It will be noted that the location of the cow stable, box stables and sheep barn — south of the storage barn — is such as to protect them in large measure from the cold winds of winter. Large yards both for cattle and sheep lie between and south of the cow stable and sheep barn.

Storage Barn. — The main floor and basement plans make the chief features of this part of the structure sufficiently clear, but there are some which call for especial notice. The large doors in the east end give access to the upper floor, which is twenty-two feet above the main floor of the building. This elevation, it will be seen, is reached by a drive with very moderate grade. This arrangement makes it possible to store hay, silage, grain, stable absorbents and bedding with a minimum of expense for labor.


STOCK BARN
AND
DAIRY SCHOOL
FIRST FLOOR
SCALE OF FEET
1894
DRAWN BY
F L CLAPP
LEAN TO
LEAN TO
PASSAGE
SHEEP
SHEEP
UP
DOWN
PASSAGE
CATTLE STALLS
CATTLE STALLS
LEAN-TO
PASSAGE
OFFICE
BOX STALLS
TRAP
UP
DOWN
HAY
ABSORBENTS
DRIVE 10 FT ABOVE MAIN FLOOR
DRIVEWAY
SILO
SILO
SILO
HAY
GRANARY
SCALES
COAT ROOM
COOLEY CREAMERS ETC
CLASSROOM
ICE ROOM
LABORATORY
DOWN
CAPACITY
CATTLE 94
SHEEP 75
HOGS 60
HAY 240 TONS
SILAGE 350 "
ABOVE SHEEP 40 TONS

On the right, as one enters these large doors, are traps communicating with large bins below for grain, which is drawn out through shoots into feed trucks on the main floor. On the left are traps through which sawdust, dry earth, plaster and similar materials may be dumped into rooms conveniently accessible from the stable. Near the east end is a set of Fairbank's hay scales. On the right, just beyond the traps for grain, is liberal floor space for the operation of heavy barn machinery. Here we have a fifteen-horse-power electric motor. Here will stand the ensilage cutter, corn-sheller, grain-mill, thresher, etc. Just beyond, to the west, are the silos on the right of the centre drive, which runs the full length of the floor. At the western end of this drive we are thirty-one feet above the ground as the main basement opens to the west. In order to enable teams to leave this floor, a space twenty feet wide on the south side is floored over, wagons being readily backed thereon by turning the team to the left, when by turning the team to the right it is possible to drive out. The balance of the space both right and left of the drive, which is fourteen feet wide, is open for hay, of which we can store one hundred and fifty tons below this floor. Above the floor there is space for an additional ninety tons. The silos will hold about three hundred and fifty tons, if but once filled and allowed to settle. If refilled after settling, they will hold about one-fourth more.

The folding doors shown at the east end of the south side of the storage barn give access to a floor eleven feet wide, which runs across the end to similar doors on the north side. Each of these doors is reached by a drive of very easy grade, held by a curved retaining wall, as shown on the side represented in the view. This cross floor is ten feet below the upper floor, and beneath it is a capacious root and vegetable cellar, reached through traps in this floor as well as through a door leading off the main floor of the barn. From this cross floor also we have access to the second floor of the granary. This cross drive is used during a large part of the time as a storeroom for wagons, carts, etc.; for, of course, it is comparatively seldom used for putting in material, and our arrangement is such that all roots and vegetables put down from it are taken out upon the main floor below.

Cow Stable. — The exterior and interior views and the plan will enable one to form tolerably clear ideas of the main features of this portion of our barn. The windows and doors upon the west side correspond in general with those shown in the view presented. There is no basement under this stable, and the cement passages and gutters are built upon solid earth and masonry. The cement floors under the shed roof at the south end are nine feet below the

stable floor, thus making it possible for us to dump manure directly into a cart or manure spreader from platforms built out from the doors at the ends of the passages behind the cattle. The manure is brought out in low barrows with water-tight boiler-iron bodies. Such a barrow in position for dumping contents stands on the western platform. The gutters behind the cows are graded from either side towards the centre, where an outlet leads into a sewer pipe connecting with a large cistern for liquid manure. The heap of earth near the middle of this stable shows where one of these cisterns was in process of construction at the time the view was taken. There is a similar cistern on the west side. From these cisterns the liquid will be pumped into a liquid-manure distributor. Kainit or sulphate of magnesia will be used in them and in the stable to prevent the loss of ammonia.

The roof has been constructed with a view to making it non-conductive. Beginning with the outer surface, we have, first, the steel (with which all our new buildings are covered) building paper and inch boards ; second, a six-inch air space ; third, building paper and matched boards ; fourth, an inch and one-half air space ; and, lastly, lath and plaster.

The view of the interior, which has been taken from a point near the south end looking towards the storage barn, shows the general arrangement.

This stable will accommodate sixty-five cows, and furnishes 1,233 cubic feet of air-space to each. A leading idea in planning the interior has been to secure smooth, hard surfaces, all readily accessible to facilitate cleaning. All ceilings and the walls of the monitor are of adamant plaster, which has been painted ; the lower walls are plain North Carolina matched pine sheathing, which has been oiled. The upper windows are all hinged at the bottom, and are moved by Ormsby's ventilating apparatus by means of cranks operated from the floors. The upper sashes in the lower windows are also hinged at the bottom, and are individually moved by means of transom lifts. The lower sashes slide into the partitions, and they are protected by iron grates. Trap doors, which are moved by means of an arrangement of cords and pulleys, are placed in the cupolas. We find that with this arrangement we are able to ventilate without having direct draught upon the animals.

We have placed in this stable specimens of the leading forms of stanchions and ties, but we are using for most of our animals the Watter's tie, which we find very satisfactory. All the animals in one section — ten to twelve — are released by a single motion of a lever, if desired. They are conveniently fastened, and can be

readily released singly. The tie is simple, and allows considerable freedom of motion to the animals.

The V trough is made of cement, and is used both for water and feed. The racks which divide the troughs into individual sections when the animals are fed are movable. A part is shown raised, which is the position when troughs are to be cleaned or the animals watered. The same arrangement prevents animals from walking through into the floor when they are turned into the stable. When the cows are fed, these racks are put down, as shown in some sections, thus preventing the animals from pushing feed lengthwise of the trough. The racks are partially balanced by the weights, so that they move easily.

The large door at the end leads to the main floor of the storage barn, and through it feed is brought in upon trucks. A similar door at the south end of this stable allows us to drive directly through with green feed. The bays for hay, the silos, granary and root cellar are all conveniently accessible, as will be seen by reference to the plans. Silage from that part of the silos below the main floor is brought in by horse and wagon.

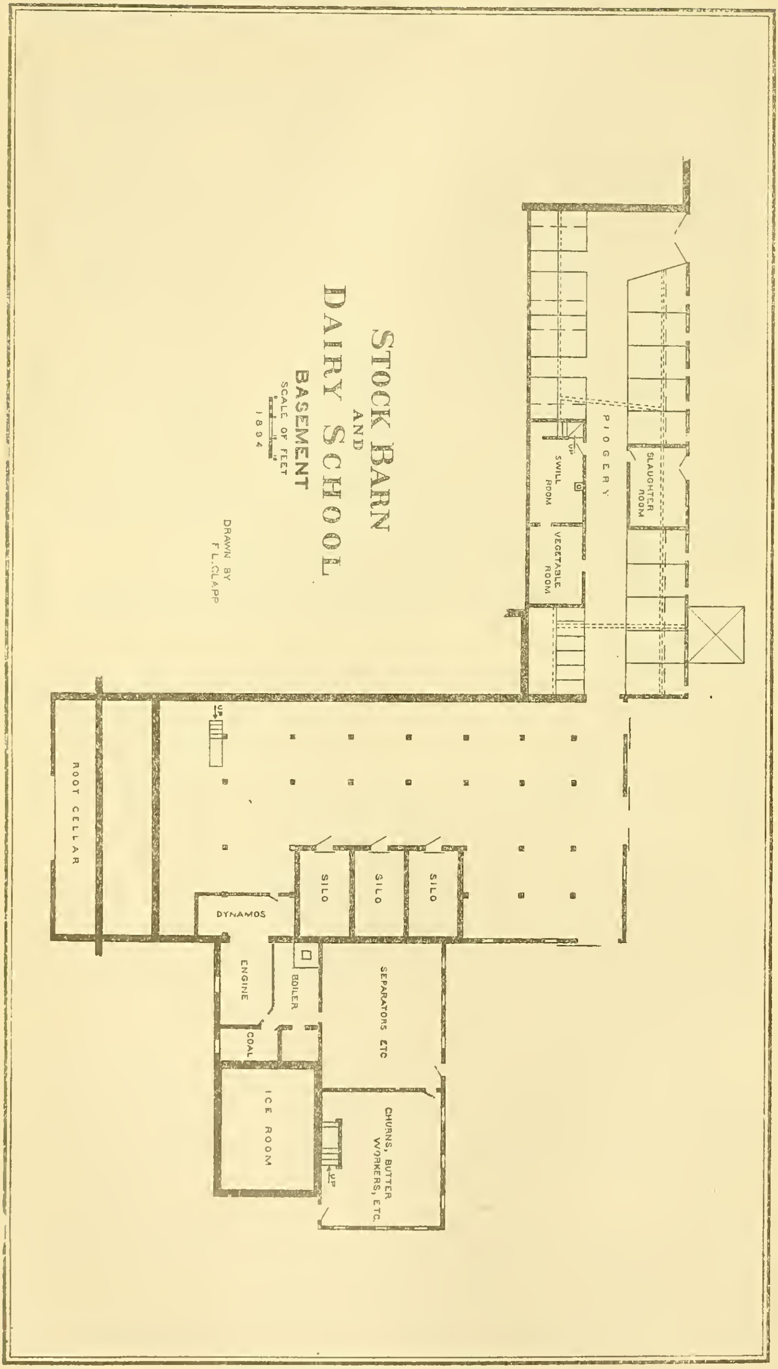
Absorbents are accessible through a door at the end of the passage behind the cows, and doors opening onto the main floor of the storage barn.

Sheep Barn. — There are in the wing known under this name two large and five small pens for sheep. The capacity is about seventy-five animals. The large pens are provided with Hall's patent sheep racks, which are very satisfactory in their working. They have also troughs with running water. Large doors at the south end give access to a sheltered and dry yard.

The stable in this wing will accommodate twenty young cattle, and at the end are four box stalls for bulls. The mangers and ties for young cattle are similar to those used in the cow stable, except that the feed and water troughs are of plank, and fixed partitions between troughs and passage have been provided in place of the movable racks.

The entire basement has a solid cement floor. In the pens for pigs the floor slopes from each side towards the half-round gutter which passes through the middle, leading to the manure pit outside. About one-half the floor space in each pen is covered by a raised plank floor, and the gutter has a hinged plank cover. It is believed the arrangement is such as to prevent drainage into passages, and that it will enable us to secure cleanliness, while at the same time saving all the valuable excreta.

All windows in the basement are hinged at the bottom; on the first floor the upper sashes are so hinged, and all hinged windows and sashes are moved in sets by Ormsby's apparatus.


STOCK BARN
AND
DAIRY SCHOOL
BASEMENT
SCALE OF FEET
1894
DRAWN BY
F.L.CLAPP
PIGGERY
UP
SWILL ROOM
VEGETABLE ROOM
SLAUGHTER ROOM
UP
ROOT CELLAR
SILO
SILO
SILO
DYNAMOS
ENGINE
BOILER
COAL
SEPARATORS ETC
ICE ROOM
UP
CHURNS, BUTTER WORKERS, ETC.

It will be noticed that both in the basement and on the first floor doors and passages are so arranged that we can drive through with carts or wagons.

The loft above the sheep will hold forty tons of hay, and can be filled by the use of a horse fork working through large trap doors above the north end of the passage. The hay for feeding is put down into the passages through traps above it.

Box Stalls. — These, nine in number, occupy the lean-to between the cow stable and the sheep barn, and extend across the north end of the latter. They are provided with plank mangers and Buckley's self-feeding watering device.

Main Basement. — The large basement under the storage barn is occupied in part by the silos and dynamo room, but will be used chiefly for storage of vehicles and implements, of which we must always have a large number for educational and experimental purposes. It has been thoroughly drained, and will be covered with a floor of concrete or cement.

Dairy School. — Accommodations for instruction in matters pertaining to the dairy, as well as for manufacturing our milk into butter, etc., are provided in a wing which lies north of the storage barn. The plans make the general arrangement clear. In the basement we have, first, boiler and engine rooms, coal storage, etc. Here we have a one hundred horse-power boiler, which, besides steam for power, furnishes hot water and steam for dairy purposes and steam for heating the four large rooms in this wing. Power is furnished by a seventy-five horse-power engine, by means of which a six hundred sixteen candle-power alternator and a four hundred sixteen candle-power generator are operated. These machines are used in generating electricity for lighting the new barns and stable and all the central college buildings. The generator furnishes the electricity for operating two motors, — the large one upon the upper floor of the storage barn, already alluded to, and a seven and one-half horse-power machine which stands in the "separator" room. This will be used in operating all dairy machinery.

The ice room has a capacity of about three hundred tons. A part of this space will be used for a cold-storage room, which will occupy the south-west corner, leading off of the room marked "churns, etc."

The two large rooms will be used respectively for the heavy and the lighter dairy machinery. Each is of ample size to allow the competitive trial of a considerable number of different forms of machines. The floors are of carbonized stone. There is a large sink, with hot and cold water and steam. Blackboards have been

provided, and it is believed that in every way the rooms will be found well suited for manufacturing and dairy school work.

The hat and coat or dressing-room on the first floor is provided with sink, with hot and cold water. The room marked "Cooley creamers," etc., is to contain apparatus to illustrate the various systems of setting milk for the separation of cream. This has sink, with hot and cold water and steam.

The class rooms and laboratory are of ample size, well lighted and ventilated. The latter will be used for instruction in chemical and microscopic examination of milk and its products.

Horse Stable and Tool Room. — The small building, of which a view is herewith presented, accommodates our horses and contains a room for small tools, a repair shop, an open hitching shed and basement for vehicles, as well as harness room, closets, etc. There are ten ordinary stalls, with the Lynn Stall Company's patent stall basin and floor, iron mangers and hay racks, and four large box stalls. Access to this portion of the stable is gained through the large door toward the east end, which stands open. Opposite this is a corresponding door on the north side, so that we are able to drive directly through. Hay is put into the loft through large trap doors above this passage by means of a horse fork. In the loft also is a vermin-proof granary. The stable is provided with water trough and running water.

The small folding door gives access to the room for small tools. This is provided with individual tool closets for permanent workmen.

The large door near the west end leads into the repair room, which runs the full width of the building. This is to be provided with bench, vises, portable forge, anvil, etc. Directly above it in the loft is space used for storage of lumber, bolts, screws, nails, parts of machines, etc. In the other end of the loft is harness repair and cleaning room.

The large doors in the west end open into the basement, which is about forty feet square and entirely clear of posts, thus making a very convenient storage for the vehicles in common use.

Quarantine Accommodations. — It is our policy, as elsewhere stated, to subject all stock purchased in localities where tuberculosis has been known to not less than six months' quarantine before putting them into our new barn. Provision for the bulls has been made by utilizing the ice house and woodshed formerly connected with the farm-house. These have been moved to a spot near the north-western part of the farm and fitted up for the purpose. The heifers will be stabled in the small building commonly spoken of as the "Hatch" barn.

Horse Barn.

In conclusion, I desire to say that to superintendent, foreman and workmen alike I am aware that I owe an unusual debt of gratitude. An enormous amount of work — far greater than those who now see the results simply can ever realize — has been accomplished, and under circumstances in many respects peculiarly trying. To the State also, for liberal appropriation for the much-needed improvements which have been made, and to superiors in the faculty and upon the board of trustees for cordial sympathy and support, I owe a similar debt of gratitude.

WILLIAM P. BROOKS,
Professor of Agriculture.

AMHERST, Dec. 21, 1894.

GIFTS.

From MASSACHUSETTS COMMISSION WORLD'S COLUMBIAN EXPOSITION, the "Agricultural exhibit of Massachusetts" and its "Exhibit of building stones."

CHILIAN COMMISSION COLUMBIAN EXPOSITION, nitrate of soda minerals.

GERMAN POTASH SYNDICATE of New York, potash, minerals and fertilizers; five tons of kainit.

STATE BOARD COLUMBIAN EXPOSITION, hemp, flax, tobacco, seeds, etc.

JAPANESE COMMISSION COLUMBIAN EXPOSITION, woods, collection of seeds, etc.

ELLIOT WRIGHT TILE COMPANY of Rittman, O., samples tiles.

ZEPHANIAH T. BREED of Boston, two weeders.

STATE EXPERIMENT STATION, collection of photographs.

CORTRIGHT STEEL ROOFING COMPANY of Philadelphia, samples of metal shingles.

MAKERS, five stanchion and cattle ties; Miller keyless locks.

G. H. B. GREEN of Belchertown, old grain sieve and cheese press.

H. E. ALVORD of Lewinsville, Va., dairy materials and Russian phosphate minerals.

IRA C. GREENE (M. A. C., '94) of Fitchburg, a gold medal to the cadet showing the greatest proficiency in the manual of arms.

MILTON H. WILLIAMS (M. A. C., '92) of Sunderland, dissections of fore and hind legs of the horse.

ANDREW L. BASSETT (M. A. C., '71) of New York city, collection of minerals from Syria.

From Asa W. Dickinson of Jersey City, N. J., a portrait of Shakespeare for the library.

Geo. W. Mills (M. A. C., '73) of Medford, thirty-five volumes medical works.

John C. Cutter (M. A. C., '72) of Worcester, nine volumes zoölogy and medicine.

Class of '98 (M. A. C.), eight volumes fiction.

Carpenter & Morehouse of Amherst, Vol. 50 of the "Amherst Record."

Mrs. Lucy Stone, "Woman's Rights Tracts."

Joseph E. Pond, Esq. of North Attleborough, seven volumes "Bee Journals."

Indian Rights Association, Welsh, "Civilization among the Sioux Indians;" "Tour of Observation among Indians and Indian Schools."

Hon. Geo. F. Hoar of Washington, D. C., one hundred and fifty-six volumes government publications.

Carl Freigau of Dayton, O., Vols. 15 and 16 of "Ohio Poland China Record."

Prof. F. H. Storer of Cambridge, two volumes "Bulletins of the Bussey Institute."

J. B. Lippincott & Co. of Philadelphia, Pa., "Nature of Mind and Human Automatism."

Prof. L. H. Bailey of Ithaca, N. Y., "Annals of Horticulture in North America," 1891, 1892.

Miss Eleanor A. Ormerod of Spring Grove, Eng., Vol. 17 of "Injurious Insects and Common Farm Pests."

John Hyde of Washington, D. C., "Geographical Concentration of American Agriculture."

Secretary for Agriculture, Melbourne, Australia, "Illustrated Description of Thistles."

John A. Porter of Hartford, Conn., "The Modern Newspaper."

Pres. F. A. Walker of Boston, "Bimetalism."

Rev. Calvin Stebbins of Worcester, "Edmund Burke; his Services as Agent of the Province of New York."

Noah Cressy of Hartford, Conn., three pamphlets pertaining to veterinary.

Ayrshire Breeders' Association, Vol. 19 of "Proceedings of Ayrshire Breeders' Association;" Vols. 7 and 8 of "Ayrshire Record."

James Means of Boston, "The Problem of Man-flight."

Association for Advancement of Women, "Annual Proceedings," 1875–94.

From College Reading-room Association, five volumes magazines.

Dr. Daniel Draper of New York, "Report of the New York Meteorological Observatory," 1894.

John Speir of Newton, Glasgow, Scot., "Effect of Foods on Milk Produce;" "Relation of Food to the Produce of the Cow."

Henry F. Osborn, "Rise of the Mammalia in North America."

Dr. W. Horace Hoskyns of Philadelphia, Penn., "Proceedings of Convention of U. S. Veterinary Medical Association," 1891–93.

J. B. Lindsey (M. A. C., '83) of Amherst, "Leather Refuse: its Value in Agriculture;" "Concerning the Digestibility of the Pentosans."

Holstein-Friesian Association, Vols. 11 and 13 of "Holstein-Friesian Herd Book."

Wm. H. Caldwell (M. A. C., '87) of Peterborough, N. H., Vols. 10 and 11 of "Herd Register of American Guernsey Cattle Club."

Sander's Publishing Company of Chicago, Ill., "Gurler's American Dairying."

American Humanitarian League, "Salt's Animals' Rights."

D. Willis James of New York, "Life of Charles Loring Brace, chiefly told in his own Letters."

Dr. T. Mitchell Prudden of New York, "Studies on the Etiology of Diphtheria."

In addition to the customary reports from the treasurer and the military department, I have the honor, in conformity to the law requiring the college in its annual report to publish such information as shall be useful to the community, to append three papers of special practical importance: the first, by Mr. Charles P. Lounsbury, on the "Orthezia," imported insects, particularly destructive in the greenhouse; the second, an illustrated article by Prof. A. C. Washburne, on "Eckhold's Omnimeter," an instrument greatly simplifying the processes of measurement and surveying; and the third, by Prof. George E. Stone, on "Plant Diseases and Their Remedies."

Respectfully submitted, by order of the trustees,

HENRY H. GOODELL,
President.

Jan. 1, 1895.

TREASURER'S REPORT.

George F. Mills, *Treasurer pro tem. of Massachusetts Agricultural College from Oct. 1, 1893, to Jan. 1, 1895.*

	Received.	Paid.
Cash on hand Oct. 1, 1893,	$141 47	–
Term bill,	6,339 17	$3,599 38
Botanical department,	7,002 90	11,341 00
Farm,	10,858 25	15,597 86
Expense,	1,543 60	12,386 25
Salary,	595 83	19,088 92
Endowment fund,	14,467 18	–
State scholarship fund,	18,750 00	–
Chemical laboratory,	998 04	637 51
Botanical laboratory,	11 00	75
Zoölogical laboratory,	20 00	39 46
Labor fund,	6,269 63	5,314 50
Gassett scholarship fund,	42 94	–
Whiting Street fund,	51 15	35 00
Grinnell prize fund,	62 50	45 00
Mary Robinson fund,	35 84	160 00
Burnham emergency fund,	200 00	70 00
Hills fund,	356 16	528 19
Extra instruction,	–	746 41
Advertising,	–	113 30
Real estate,	–	69 25
Library fund,	551 46	551 46
Investment, N. Y. C. & H. R. R. R. stock,	3 75	50 50
Special appropriation, underdraining,	–	251 08
Insurance,	307 50	1,106 62
Insurance, barn,	4,000 00	640 99
Insurance, vehicles, tools, etc.,	1,750 00	1,069 79
Insurance, hay, grain, etc.,	899 00	899 00
Insurance, live stock,	20 00	20 00
Electric plant,	–	62 12
Cash on hand Jan. 1, 1895,	–	853 13
	$75,277 37	$75,277 37

This is to certify that I have this day examined the accounts of George F. Mills, treasurer *pro tem.* of the Massachusetts Agricultural College, from Oct. 1, 1893, to Jan. 1, 1895, and find the same correct, properly kept and all disbursements vouched for, the balance in the treasury being eight hundred and fifty-three and 13–100 dollars ($853.13), which sum is shown to be in the hands of the treasurer.

CHARLES A. GLEASON, *Auditor.*

Amherst, Dec. 26, 1894.

Cash Balance, as shown by the Treasurer's Statement, belongs to the Following Accounts:

Gassett scholarship fund,	$87 64
Whiting Street fund,	66 06
Grinnell prize fund,	37 50
Mary Robinson fund,	37 24
Burnham emergency fund,	239 30
Hills fund,	147 50
Labor fund,	237 89
	$853 13

Bills Receivable Jan. 1, 1895.

Term bill,	$1,840 87
Botanical department,	203 67
Farm,	753 54
Expense,	52 93
Chemical laboratory,	653 95
Botanical laboratory,	28 00
Zoölogical laboratory,	84 00
Insurance,	60 00
	$3,676 96

Bills Payable Jan. 1, 1895.

Term bill,	$6 00
Botanical department,	4 56
Farm,	1,299 18
Expense,	295 37
Labor fund,	220 94
Insurance, barn,	3,359 01
Insurance, vehicles, tools, etc.,	680 21
	$5,865 27

Inventory — real estate.

Land.

	Cost.	
College farm,	$37,000 00	
Pelham quarry,	500 00	
Bangs place (with house, shed and barn),	2,525 00	
		$40,025 00

Buildings.

	Cost.	
Drill hall,	$6,500 00	
Powder house,	75 00	
Stone chapel,	31,000 00	
South dormitory,	37,000 00	
Amounts carried forward,	$74,575 00	$40,025 00

Amounts brought forward,	$74,575 00	$40,025 00
North dormitory,	36,000 00	
Laboratory,	10,360 00	
Farm house,	4,000 00	
Horse barn,	5,000 00	
Farm barn and dairy school,	33,000 00	
Graves house and barn,	8,000 00	
Boarding-house,	8,000 00	
Botanic museum,	5,180 00	
Botanic barn,	1,500 00	
Botanic barn addition,	1,000 00	
Tool house,	2,000 00	
Durfee plant house and fixtures,	12,000 00	
Small plant house with vegetable cellar and cold grapery,	4,700 00	
President's house,	11,500 00	
Dwelling houses, purchased with farm,	7,500 00	
		224,315 00
		$264,340 00

PERSONAL PROPERTY.

Electric plant,	$8,700 00
New York Central and Hudson River Railroad stock,	100 50
Botanical department,	11,942 13
Farm,	12,258 00
Chemical laboratory,	2,529 00
Natural history collection,	4,758 79
Veterinary department,	1,443 39
Agricultural department,	2,595 00
Physics department,	5,471 28
Library,	15,823 00
Fire apparatus,	500 00
Furniture,	640 00
Books in treasurer's office,	427 58
	$67,188 67

SUMMARY.

Assets.

Total value of real estate, per inventory,	$264,340 00
Total value of personal property, per inventory,	67,188 67
Bills receivable, per inventory,	3,676 96
	$335,205 63

Liabilities.

Bills payable, per inventory,	5,865 27
	$329,340 36

Maintenance Funds.

Technical educational fund, United States grant,	$219,000 00
Technical educational fund, State grant, .	141,575 35
	$360,575 35

Two-thirds of the income from these funds is paid to the treasurer of the college and one-third to the Institute of Technology. Amount received by the college treasurer from Oct. 1, 1893, to Jan. 1, 1895, ...	$14,467 18
Hills fund, the gift of Messrs. L. M. and H. F. Hills of Amherst, now amounts to $8,542. By conditions of the gift the income is to be used for the maintenance of a botanic garden. Income from Oct. 1, 1892, to Jan. 1, 1895, ...	356 16

Scholarship Funds.

State scholarship fund, $10,000. This sum was appropriated by the Legislature in 1886, and is paid to the college treasurer in quarterly payments. Amount received from Oct. 1, 1893, to Jan. 1, 1895, ...	12,500 00
Annual State appropriation, $10,000. This sum was appropriated for four years by the Legislature of 1889, and continued for another four years by the Legislature of 1892, for the endowment of additional chairs of instruction and for general expense. Five thousand dollars of this sum was set apart as a labor fund, to be used in payment of labor performed by needy and worthy students. Amount received from annual State appropriation for college expenses from Oct. 1, 1893, to Jan. 1, 1895, ...	6,250 00
Amount received as labor fund, ...	6,250 00
Whiting Street fund, $1,000. This fund is a bequest without conditions. To it was added, by vote of the trustees in January, 1887, the interest accrued on the bequest, $260. Amount of the fund, Jan. 1, 1895, $1,260. Income from Oct. 1, 1893, to Jan. 1, 1895, ...	51 15
Gassett scholarship fund, $1,000. This sum was given by Hon. Henry Gassett as a scholarship. Income from Oct. 1, 1893, to Jan. 1, 1895, ...	42 94
Mary Robinson fund, $858. This fund was given without conditions. The income from it has been appropriated for scholarships to worthy and needy students. Income from Oct. 1, 1893, to Jan. 1, 1895, ...	35 84
Amount carried forward, ...	$39,953 27

Amount brought forward, ...	$39,953 27

PRIZE FUNDS.

Grinnell prize fund, $1,000. This fund is the gift of Ex-Gov. William Claflin, and is called Grinnell fund in honor of his friend. The income from it is appropriated for two prizes, to be given to the two members of the graduating class who pass the best examination in agriculture. Income from Oct. 1, 1893, to Jan. 1, 1895, ...	62 50

MISCELLANEOUS FUNDS.

Library fund for the benefit of the library. Amount of fund, Dec. 31, 1894, $8,855.45.	
Burnham emergency fund, $5,000. This fund is a bequest of Mr. T. O. H. P. Burnham, late of Boston, and was made without conditions. The trustees have voted that this fund be kept intact, and that the income from it be used by the trustees for such purposes as they believe to be for the best interests of the college. Income from Oct. 1, 1893, to Jan. 1, 1895, ...	200 00
Income from Oct. 1, 1893, to Jan. 1, 1895, ...	$40,215 77

To this sum must be added amount of tuition and room rent, and receipts from sales from farm and botanic gardens. These amounts can be learned from treasurer's statement, tuition and room rent being included in term bill account.

REPORT OF THE PRESIDENT OF THE MASSACHUSETTS AGRICULTURAL COLLEGE TO THE SECRETARY OF AGRICULTURE AND THE SECRETARY OF THE INTERIOR, AS REQUIRED BY ACT OF CONGRESS OF AUGUST 30, 1890, IN AID OF COLLEGES OF AGRICULTURE AND THE MECHANIC ARTS.

I. Condition and Progress of the Institution, Year ended June 30, 1894.

The condition of the Massachusetts Agricultural College during the year ended June 30, 1894, has been exceedingly prosperous. The college has enrolled 214 students, the largest number in its history, while its graduating class, 33 in number, and more than 15 per cent of all the students in attendance, is the largest ever graduated from the institution. An assistant in the chair of zoölogy and a second assistant in the chair of botany and horticulture have been added to the faculty, making a total of 18 professors and assistants actively engaged in the work of daily instruction.

The results of the elective system in the studies of the senior year have been most gratifying. Not only has there been a marked increase in the interest in study shown by the members of this class, but this interest has been communicated to the other classes also, so that a general quickening of the intellectual life of the students has been apparent. It is yet too soon to speak intelligently of the results of the establishment of the two years' course. Twenty-three students have been found in this class, and the practical character of the instruction received has been fully appreciated by them.

Valuable courses of lectures have been given during the year by Sir Henry Gilbert of the Rothamsted Station, England, by Dr. B. E. Fernow and Maj. Henry E. Alvord.

A valuable addition to the equipment of the college has been made by the building of the new barns, at the cost of $36,000. These include a main fodder barn, with wings for swine, cattle and sheep, and a horse barn. In connection with the main barn a dairy school has been equipped, in which practical instruction will be given to students. The old barn erected in 1869 was destroyed by fire on the night of June 18. The most serious loss in connection with the fire was that of valuable agricultural implements that had been secured as a nucleus of an agricultural museum.

II. Receipts for and during the Year ended June 30, 1894.

1. State aid: (*a*) Income from endowment,	$2,655 92
(*b*) Appropriations for building or other special purposes,	10,000 00
(*c*) Appropriations for current expenses,	10,000 00
2. Federal aid: (*a*) Income from land grant, act of July 2, 1862,	7,300 00
(*b*) For experiment stations, act of March 2, 1887,	15,000 00
(*c*) Additional endowment, act of Aug. 30, 1890,	12,666 66
3. Fees and all other sources,	800 00
Total receipts,	$58,422 58

III. Expenditures for and during the Year ended June 30, 1894.

1. College of Agriculture and Mechanic Arts,	$43,422 58
2. Experiment Station,	15,000 00
Total expenditures,	$58,422 58

IV. Property and Equipment, Year ended June 30, 1894.

Agricultural department —	
Value of buildings,	$263,765 00
Of other equipment,	$67,783 11
Total number of acres,	384
Acres under cultivation,	244
Acres used for experiments,	58
Value of farm lands,	$40,025 00

V. Faculty during the Year ended June 30, 1894.

	Male.	Female.
1. College of Agriculture and Mechanic Arts: collegiate and special classes,	18	–
2. Number of staff of Experiment Station,	10	1
Total, counting none twice,	23	1

VI. Students during the Year ended June 30, 1894.

	Male.	Female.
1. College of Agriculture and Mechanic Arts: collegiate and special classes,	201	–
2. Graduate courses,	13	–
Total, counting none twice,	214	

VII. Library, Year ended June 30, 1894.

1. Number of bound volumes June 30, 1892,	* 14,040
2. Bound volumes added during year ended June 30, 1893,	* 1,400
Total bound volumes,	15,440

* Pamphlets, none.

MILITARY DEPARTMENT.

AMHERST, MASS., Dec. 31, 1894.

To President H. H. GOODELL.

SIR: — I have the honor to submit the following report of the military department of the college for the year ending Dec. 31, 1894: —

Since my last report, dated Sept. 30, 1893, the equipment of the military department has been increased by obtaining from the general government heliographs and signal flags, carriages with implements for two 3.2-inch breech-loading steel field guns (the guns themselves will soon be shipped); also by twenty cadet Springfield rifles and twenty-two sets of infantry accoutrements.

The total number of students receiving military instruction at the present time is one hundred and thirty.

The following is a list of the United States government property now on hand: —

Ordnance.

2 light 12-pound brass guns with implements.
2 sets implements for 3.2-inch breech-loading steel guns.
2 8-inch mortars with implements.
4 gun carriages.
2 gun caissons.
2 mortar beds.
2 mortar platforms.
147 Springfield cadet rifles.
147 infantry accoutrements, sets.
51 headless shell extractors.
100 blank cartridges for field guns.
5,000 metallic ball cartridges.
1,000 metallic blank cartridges.
300 friction primers.
4,000 pasters.
100 targets, A and B.
30,000 cartridge primers.
25,000 round balls.
1 set hand reloading tools.
100 pounds small arms powder.

Signal Property.

2 heliographs, complete.
6 2-foot white flags.
6 2-foot red flags.
6 canvas cases and straps.
12 joints of staffs.

The armory building is in good condition. I would strongly recommend, however, as in previous reports, that a gallery be placed across the south end of the drill hall to accommodate visitors. Much inconvenience — not only to them, but particularly to those drilling — is now caused by having them on the floor of the hall. I believe a gallery answering all purposes could be put in for $200.

A gun shed and a suitable place for having gallery practice is also much needed. We now have no suitable place for storing our field guns during the winter months. We are about to be supplied with new guns, and a building should be provided for their shelter.

To obtain good results at target practice, instruction in gallery practice is required. We have now no place where such instruction can be held. If a gun shed is built, for very little extra expense a shooting gallery could be included, using one side of the building for that purpose. A suitable building, to be used both as a gun shed and shooting gallery, can be built for $1,400.

THEORETICAL AND PRACTICAL INSTRUCTION.

Theoretical. — The students of the senior class are required to attend, for one hour each week, during the college year, theoretical instruction in the art and science of war. During the past year the only text-book used has been the United States Infantry Drill Regulations. All other instruction has been by lectures, much more ground having been covered in this way than if text-books had been used. Lectures have been given on military law, explosives, fortifications, art and science of war, army administration, composition of armies, the military used as an aid to the civil authority, etc.

The freshman class receive theoretical instruction for one hour each week during the fall term. This instruction has been confined to recitations in the United States Infantry Drill Regulations. When the time permitted, supplementary instruction has been given them by lectures on minor subjects, such as target practice, military customs, etc. It is desirable, when the new

field guns are received, that the sophomore class have theoretical instruction in the United States Artillery Drill Regulations.

Practical. — For practical instruction the battalion has the same organization as in previous years, — that is, four companies and a band; this instruction has been in the "school of the soldier," "school of the company," "school of the battalion" and in "extended order drill." During the winter term instruction in "sabre drill" was given the junior class; the sophomore class received thorough instruction in "bayonet exercise." Instruction in artillery has also been given the sophomore class, and the entire battalion has target practice, details being sent each drill day, when the weather permits, to the target range for that purpose. The total number of shots fired during the last college year was 3,140, the average number of shots per student being 22; the arm used was the Springfield cadet rifle. Certain members of the senior class have received very thorough instruction in signalling, using both the flags and heliographs.

All students of the college except post-graduates are required to attend three drills each week, unless excused for some physical disability, each drill being for one hour. The discipline in the battalion is excellent; all the students appear to recognize its importance and cheerfully conform to its requirements.

In this connection I especially desire to call attention to the stand the faculty of the college has taken with respect to the military department. It has been very gratifying to me since I have been stationed here to find the college faculty always ready and willing to assist me in every possible manner.

The following three members of the last graduating class were reported by me to the Adjutant-General of the Army and to the Adjutant-General of the State of Massachusetts as having shown the greatest proficiency in the art and science of war: —

T. S. Bacon,	Natick, Mass.
A. C. Curtis,	Brooklyn, N. Y.
G. H. Merwin,	Westport, Conn.

The military prize this year was awarded G. H. Merwin of Westport, Conn.

A prize of a gold medal has been offered by Mr. I. C. Greene, a member of the last graduating class, to be given to the student showing the greatest proficiency in the "manual of arms." It is intended that the drill for said prize shall take place about the close of the winter term.

The battalion is at present organized as follows: —

Commandant.

Lieut. W. M. Dickinson, ... U. S. Army.

Commissioned Staff.

Cadet First Lieutenant and Adjutant, . . E. H. Clark.
Cadet First Lieutenant and Quartermaster, . T. P. Foley.
Cadet First Lieutenant and Fire Marshal, . . H. B. Read.
Cadet First Lieutenant and Assistant Instructor of Musketry, ... R. A. Cooley.
Cadet First Lieutenant and Assistant Instructor in Signalling, ... W. L. Bemis.

Non-Commissioned Staff.

Cadet Sergeant-Major, ... F. E. DeLuce.
Cadet Quartermaster-Sergeant, ... N. Shultis.
Cadet Corporal and Armorer, ... S. W. Fletcher.

Color Guard.

Cadet Color Sergeant, ... H. W. Rawson.
Cadet Color Corporal, ... F. L. Clapp.
Cadet Color Corporal, ... E. W. Poole.

Band.

Cadet First Lieutenant Commanding Band, . W. C. Brown.
Cadet First Sergeant and Band Leader, . . W. B. Harper.
Cadet Drum Major, ... A. S. Kinney.
Cadet Band Corporal, ... A. B. Cook.

Companies.

Cadet Capt. H. A. Ballou, . . . assigned to Company A.
Cadet Capt. F. L. Warren, . . . assigned to Company D.
Cadet Capt. M. J. Sullivan, . . . assigned to Company B.
Cadet Capt. R. S. Jones, ... assigned to Company C.
Cadet First Lieut. S. P. Toole, . . . assigned to Company A.
Cadet First Lieut. H. S. Fairbanks, . . assigned to Company D.
Cadet First Lieut. C. W. Crehore, . . assigned to Company B.
Cadet First Lieut. W. L. Morse, . . assigned to Company C.
Cadet Second Lieut. H. L. Frost, . . assigned to Company A.
Cadet Second Lieut. G. A. Billings, . . assigned to Company D.
Cadet Second Lieut. C. B. Lane, . . assigned to Company B.
Cadet Second Lieut. W. A. Root, . . assigned to Company C.
Cadet First Sergeant P. A. Leamy, . . assigned to Company A.
Cadet First Sergeant R. P. Nichols, . . assigned to Company B.
Cadet First Sergeant F. H. Read, . . assigned to Company C.
Cadet First Sergeant H. C. Burrington, . assigned to Company D.
Cadet Sergeant B. K. Jones, . . . assigned to Company B.

Cadet Sergeant H. T. Edwards, . .	assigned to Company A.
Cadet Sergeant F. P. Washburn, . .	assigned to Company D.
Cadet Sergeant W. L. Pentecost, . .	assigned to Company C.
Cadet Sergeant F. B. Shaw, . . .	assigned to Company D.
Cadet Sergeant H. W. Moore, . . .	assigned to Company C.
Cadet Sergeant M. E. Sellew, . . .	assigned to Company B.
Cadet Sergeant I. C. Poole, . . .	assigned to Company A.
Cadet Corporal J. L. Marshall, . .	assigned to Company A.
Cadet Corporal A. M. Kramer, . . .	assigned to Company C.
Cadet Corporal S. Saito, ...	assigned to Company B.
Cadet Corporal S. Sastré, ...	assigned to Company D.
Cadet Corporal C. A. Nutting, . . .	assigned to Company A.
Cadet Corporal G. Tsuda, ...	assigned to Company B.
Cadet Corporal C. A. King, . . .	assigned to Company D.
Cadet Corporal G. D. Leavens, . . .	assigned to Company C.
Cadet Corporal J. M. Barry, . . .	assigned to Company D.
Cadet Corporal C. I. Goessmann, . .	assigned to Company A.
Cadet Corporal C. A. Norton, . . .	assigned to Company B.

Respectfully submitted,

W. M. DICKINSON,
Lieut. United States Army.

CALENDAR FOR 1895–96.

1895.

January 3, Thursday, winter term begins, at 8.15 A.M.

March 20, Wednesday, winter term closes, at 10.30 A.M.

April 3, Wednesday, spring term begins, at 8.15 A.M.

June 15, Saturday, Grinnell prize examination of the senior class in agriculture.

June 16, Sunday,	Baccalaureate sermon. Address before the College Young Men's Christian Association.
June 17, Monday, .	. Burnham prize speaking.
June 18, Tuesday,	Meeting of the alumni. Flint prize oratorical contest. Class day exercises. Military exercises. Reception by the president and trustees.
June 19, Wednesday, .	Commencement exercises.

June 20–21, Thursday and Friday, examinations for admission, at 9 A.M., Botanic Museum, Amherst; at Jacob Sleeper Hall, Boston University, 12 Somerset Street, Boston; and at Sedgwick Institute, Great Barrington. Two full days are required for examination, and candidates must come prepared to stay that length of time.

September 3–4, Tuesday and Wednesday, examinations for admission, at 9 A.M., Botanic Museum.

September 5, Thursday, fall term begins, at 8.15 A.M.

December 18, Wednesday, fall term closes, at 10.30 A.M.

1896.

January 2, Thursday, winter term begins, at 8.15 A.M.

March 25, Thursday, winter term closes, at 10.30 A.M.

THE CORPORATION.

	Term expires.
DANIEL NEEDHAM of GROTON,	1896
JAMES DRAPER of WORCESTER,	1896
HENRY S. HYDE of SPRINGFIELD,	1897
MERRITT I. WHEELER of GREAT BARRINGTON,	1897
JAMES S. GRINNELL of GREENFIELD,	1898
JOSEPH A. HARWOOD of LITTLETON,	1898
WILLIAM H. BOWKER of BOSTON,	1899
J. D. W. FRENCH of BOSTON,	1899
J. HOWE DEMOND of NORTHAMPTON,	1900
ELMER D. HOWE of MARLBOROUGH,	1900
FRANCIS H. APPLETON of LYNNFIELD,	1901
WILLIAM WHEELER of CONCORD,	1901
ELIJAH W. WOOD of WEST NEWTON,	1902
CHARLES A. GLEASON of NEW BRAINTREE,	1902

Members Ex Officio.

HIS EXCELLENCY GOVERNOR FREDERIC T. GREENHALGE,
President of the Corporation.

HENRY H. GOODELL, *President of the College.*

FRANK A. HILL, *Secretary of the Board of Education.*

WILLIAM R. SESSIONS, *Secretary of the Board of Agriculture.*

JAMES S. GRINNELL of GREENFIELD,
Vice-President of the Corporation.

WILLIAM R. SESSIONS of HAMPDEN, *Secretary.*

GEORGE F. MILLS of AMHERST, *Treasurer pro tempore.*

CHARLES A. GLEASON of NEW BRAINTREE, *Auditor.*

Committee on Finance and Buildings.*

JAMES S. GRINNELL. HENRY S. HYDE.
J. HOWE DEMOND. CHARLES A. GLEASON.
DANIEL NEEDHAM, *Chairman.*

Committee on Course of Study and Faculty.*

WILLIAM H. BOWKER. JOSEPH A. HARWOOD.
FRANCIS H. APPLETON. J. D. W. FRENCH.
WILLIAM WHEELER, *Chairman.*

Committee on Farm and Horticultural Departments.*

ELIJAH W. WOOD. JAMES DRAPER.
ELMER D. HOWE. MERRITT I. WHEELER.
WILLIAM R. SESSIONS, *Chairman.*

Committee on Experiment Department.*

DANIEL NEEDHAM. ELIJAH W. WOOD.
FRANCIS H. APPLETON. WILLIAM H. BOWKER.
WILLIAM WHEELER. JAMES DRAPER.
WILLIAM R. SESSIONS, *Chairman.*

Board of Overseers.

STATE BOARD OF AGRICULTURE.

Examining Committee of Overseers.

A. C. VARNUM (*Chairman*), . . of Lowell.
GEORGE CRUICKSHANKS, . . of Fitchburg.
E. A. HARWOOD, ... of North Brookfield.
J. E. KIMBALL, ... of Oxford.
JOHN BURSLEY, ... of Barnstable.

The Faculty.

HENRY H. GOODELL, LL.D., *President,*
Professor of Modern Languages and English Literature.

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* The president of the college is ex officio a member of each of the above committees.

LEVI STOCKBRIDGE,
Professor of Agriculture, Honorary.

CHARLES A. GOESSMANN, Ph.D., LL.D.,
Professor of Chemistry.

SAMUEL T. MAYNARD, B.Sc.,
Professor of Botany and Horticulture.

CLARENCE D. WARNER, B.Sc.,
Professor of Mathematics and Physics.

CHARLES WELLINGTON, Ph.D.,
Associate Professor of Chemistry.

CHARLES H. FERNALD, Ph.D.,
Professor of Zoölogy.

Rev. CHARLES S. WALKER, Ph.D.,
Professor of Mental and Political Science.

WILLIAM P. BROOKS, B.Sc.,
Professor of Agriculture.

GEORGE F. MILLS, M.A.,
Professor of English.

JAMES B. PAIGE, V.S.,
Professor of Veterinary Science.

WALTER M. DICKINSON, 1st Lieut. 17th Infantry, U.S.A.,
Professor of Military Science and Tactics.

A. COURTENAY WASHBURNE,
Assistant Professor of Mathematics.

HERMAN BABSON, B.A.,
Assistant Professor of English.

GEORGE E. STONE, Ph.D.,
Assistant Professor of Botany.

EDWARD R. FLINT, Ph.D.,
Assistant Professor of Chemistry.

FRED S. COOLEY, B.Sc.,
Assistant Professor of Agriculture and Farm Superintendent.

RICHARD S. LULL, B.Sc.,
Assistant Professor of Zoölogy.

RALPH E. SMITH, B.Sc.,
Instructor in German and Botany.

ROBERT W. LYMAN, LL.B.,
Lecturer on Farm Law.

HENRY H. GOODELL, LL.D.,
Librarian.

Graduates of 1894.*

Alderman, Edwin Hammond, .	Middlefield.
Averell, Fred Gilbert (Boston Univ.), ...	Amherst.
Bacon, Linus Hersey (Boston Univ.), ...	Spencer.
Bacon, Theodore Spalding (Boston Univ.), ...	Natick.
Barker, Louis Morton (Boston Univ.), ...	Hanson.
Boardman, Edwin Loring (Boston Univ.), ...	Sheffield.
Brown, Charles Leverett, . .	Feeding Hills.
Curtis, Arthur Clement (Boston Univ.), ...	Brooklyn, N. Y.
Cutter, Arthur Hardy (Boston Univ.), ...	Pelham, N. H.
Davis, Perley Elijah (Boston Univ.), ...	Worcester.
Dickinson, Eliot Taylor (Boston Univ.), ...	Amherst.
Fowler, Halley Melville (Boston Univ.), ...	South Gardner.
Fowler, Henry Justin (Boston Univ.), ...	North Hadley.
Gifford, John Edwin (Boston Univ.), ...	Brockton.

* The annual report, being made in January, necessarily includes parts of two academic years, and the catalogue bears the names of such students as have been connected with the college during any portion of the year 1894.

Greene, Frederic Lowell (Boston Univ.),	Shrewsbury.
Greene, Ira Charles (Boston Univ.),	Fitchburg.
Higgins, Charles Herbert (Boston Univ.),	Dover.
Howard, Samuel Francis (Boston Univ.),	Wilbraham.
Keith, Thaddeus Fayette (Boston Univ.),	Fitchburg.
Kirkland, Archie Howard (Boston Univ.),	Norwich.
Lounsbury, Charles Pugsley (Boston Univ.),	Allston.
Manley, Lowell (Boston Univ.),	Brockton.
Mann, Henry Judson,	Maplewood.
Merwin, George Henry (Boston Univ.),	Westport, Conn.
Morse, Alvertus Jason (Boston Univ.),	Belchertown.
Pomeroy, Robert Ferdinand (Boston Univ.),	South Worthington.
Putnam, Joseph Harry (Boston Univ.),	West Sutton.
Sanderson, William Edwin (Boston Univ.),	Hingham.
Smead, Horace Preston (Boston Univ.),	Greenfield.
Smith, George Eli (Boston Univ.),	Sheffield.
Smith, Ralph Eliot (Boston Univ.),	Newton Centre.
Spaulding, Charles Harrington (Boston Univ.),	East Lexington.
Walker, Claude Frederic (Boston Univ.),	Amherst.
White, Elias Dewey (Boston Univ.),	South Sherborn.
Total,	34

Senior Class.

Ballou, Henry Arthur,	West Fitchburg.
Bemis, Waldo Louis,	Spencer.
Billings, George Austin,	South Deerfield.

Brown, William Clay,	Peabody.
Burgess, Albert Franklin,	Rockland.
Clark, Edile Hale,	Spencer.
Clark, Harry Edward,	Wilbraham.
Cooley, Robert Allen,	South Deerfield.
Crehore, Charles Winfred,	Chicopee.
Dickinson, Charles Morrison,	Chicago, Ill.
Fairbanks, Herbert Stockwell,	Amherst.
Foley, Thomas Patrick,	Natick.
Frost, Harold Locke,	Arlington.
Hemenway, Herbert Daniel,	Williamsville.
Jones, John Horace,	Pelham.
Jones, Robert Sharp,	Dover.
Kuroda, Shiro,	Yamanouchi, Kitamura, Japan.
Lane, Clarence Bronson,	Killingworth, Conn.
Lewis, Henry Waldo,	Rockland.
Marsh, Jasper,	Danvers Centre.
Morse, Walter Levi,	Middleborough.
Potter, Daniel Charles,	Fairhaven.
Read, Henry Blood,	Westford.
Root, Wright Asahel,	Deerfield.
Smith, Arthur Bell,	North Hadley.
Stevens, Clarence Lindon,	Sheffield.
Sullivan, Maurice John,	Amherst.
Tobey, Frederick Clinton,	West Stockbridge.
Toole, Stephen Peter,	Amherst.
Warren, Franklin Lafayette,	Shirley.
White, Edward Albert,	Ashby.
Total,	31

Junior Class.

Burrington, Horace Clifton,	Charlemont.
Clapp, Frank Lemuel,	Dorchester.
Cook, Allen Bradford,	Petersham.
Day, Gilbert,	South Groveland.
DeLuce, Frank Edmund,	Warren.
Dodge, William Bradford,	Jamaica Plain.
Edwards, Harry Taylor,	Chesterfield.
Fletcher, Stephen Whitcomb,	Rock.
Green, Josiah Elton,	Spencer.
Hammar, James Fabens,	Swampscott.
Harper, Walter Benjamin,	Wakefield.
Hayward, Ralph Lyon,	Uxbridge.

Jones, Benjamin Kent, . .	Middlefield.
Kinney, Asa Stephen, . .	Worcester.
Kramer, Albin Maximilian, .	Clinton.
Leamy, Patrick Arthur, . .	Petersham.
Marshall, James Laird, . .	South Lancaster.
Moore, Henry Ward, . . .	Worcester.
Nichols, Robert Parker, . .	West Norwell.
Nutting, Charles Allen, . .	North Leominster.
Pentecost, William Lewis, . .	Worcester.
Poole, Erford Wilson, . .	North Dartmouth.
Poole, Isaac Chester, . .	North Dartmouth.
Rawson, Herbert Warren, . .	Arlington.
Read, Frederick Henry, . .	Wilbraham.
Roper, Harry Howard, . .	East Hubbardston.
Saito, Seijiro, ...	Nemuro, Japan.
Sastré de Verand, Salome, . .	Tabasco, Mexico.
Scannell, Michael Edward, . .	Amherst.
Sellew, Merle Edgar, . . .	East Longmeadow.
Shaw, Frederic Bridgman, . .	South Amherst.
Shultis, Newton, . . .	Medford.
Tsuda, George, ...	Tokyo, Japan.
Washburn, Frank Porter, . .	North Perry, Me.
Total, ...	34

Sophomore Class.

Allen, Harry Francis, . .	Northborough.
Allen, John William, . . .	Northborough.
Armstrong, Herbert Julius, .	Sunderland.
Barclay, Frederick White, . .	Kent, Conn.
Barry, John Marshall, . .	Boston.
Bartlett, James Lowell, . .	Salisbury.
Cheney, Liberty Lyon, . .	Southbridge.
Clark, Lafayette Franklin, .	West Brattleborough, Vt.
Colby, Frederick William, . .	Roxbury.
Cook, Maurice Elmer, . .	Shrewsbury.
Drew, George Albert, . .	Westford.
Eddy, John Richmond, . .	Boston.
Emrich, John Albert, . .	Amherst.
Farnsworth, Robert Leroy, .	Turner's Falls.
Felch, Percy Fletcher, . .	Ayer.
Goessmann, Charles Ignatius, .	Amherst.
Howe, Herbert Frank, . .	North Cambridge.

Hunter, Herbert Colman, . .	South Natick.
King, Charles Austin, . .	East Taunton.
Leavens, George Davison, . .	Pawtucket, R. I.
Mansfield, George Rogers, .	Gloucester.
Millard, Frank Cowperthwait, .	North Egremont.
Norton, Charles Ayer, . .	Lynn.
Nowell, Allen March, . .	Winchester.
Palmer, Clayton Franklin, . .	Stockbridge.
Palmer, Edward Dwight, . .	Amherst.
Peters, Charles Adams, . .	Greendale.
Ranlett, Charles Augustus, .	South Billerica.
Sherman, Carleton Farrar, .	Jamaica Plain.
Smith, Jr., Philip Henry, . .	South Hadley Falls.
Vaughan, Robert Henry, . .	Worcester.
Walsh, Thomas Francis, . .	North Amherst.
West, Harold Livingstone, .	Pullman, Wash.
Total, ...	33

Freshman Class.

Baxter, Charles Newcomb, .	Quincy.
Birnie, Alexander Cullen, . .	Ludlow.
Charmbury, Thomas Herbert, .	Amherst.
Clark, Clifford Gay, . . .	Sunderland.
Eaton, Julian Stiles, . . .	Nyack, N. Y.
Fisher, Willis Sikes, . . .	Ludlow.
Holt, Henry Day, . . .	Amherst.
Hubbard, George Caleb, . .	North Amherst.
Kinsman, Willard Quincy, . .	Ipswich.
Montgomery, Jr., Alexander, .	Natick.
Nickerson, John Peter, . .	West Harwich.
Thompson, George Harris Austin,	Lancaster.
Warden, Randall Duncan, . .	Roxbury.
Wiley, Samuel William, . .	Amherst.
Wolcott, Herbert Raymond, .	Amherst.
Wright, George Henry, . .	Deerfield.
Total, ...	16

Second Year.

Bailey, George Henry, . .	Middleborough.
Bagg, Elisha Aaron, . . .	West Springfield.
Beaman, Dan Ashley, . .	Leverett.
Burnham, George Louis, . .	Andover.

Delano, Charles Wesley, . .	North Duxbury.
Dutton, Arthur Edwin, . .	Chelmsford.
Gibbs, Meltiah Tobey, . .	New Bedford.
Hall, Albert Durrell, . . .	West Newton.
Hooker, William Anson, . .	Amherst.
Huntress, Louis Maynard, . .	Westfield.
Kinsman, Ernest Eugene, . .	Heath.
Lane, Frank Pitkin, . . .	Oak Park, Ill.
Rice, Benjamin Willard, . .	Northborough.
Rising, Albert Shepard, . .	Westfield.
Sherman, Harry Robinson, . .	Dartmouth.
Stearns, Harold Everett, . .	Conway.
Sweetser, Frank Eaton, . .	Danvers.
Tisdale, Fred Alvin, . . .	North Amherst.
Todd, Frederick Gage, . .	Dorchester.
Wentzell, William Benjamin, .	Amherst.
Total, ...	20

First Year.

Alexander, Leon Rutherford, .	East Northfield.
Atkins, Harvey Robbins, . .	North Amherst.
Barrett, Frederick Eugene, . .	Framingham.
Blair, Claude Addison, . .	Amherst.
Brainard, Everett Eugene, . .	Amherst.
Canto, Ysidro Herrera, . .	Cansahcab, Yucatan, Mexico.
Capen, Elwyn Winslow, . .	Stoughton.
Coleman, Robert Parker, . .	West Pittsfield.
Courtney, Howard Scholes, .	Attleborough.
Crook, Alfred Clifton, . .	Portland, Me.
Davis, John Alden, . . .	East Longmeadow.
Dickinson, Harry Porter, . .	Sunderland.
Eaton, Williams, . . .	North Middleborough.
Gile, Alfred Dewing, . . .	Worcester.
Glynn, Alfred, ...	Amherst.
Lincoln, Leon Emory, . .	Taunton.
Manzanilla, Lorenzo Montore, .	Merida, Yucatan, Mexico.
Pasell, George Walter, . .	New Bedford.
Potter, George Henry, . .	North Dartmouth.
Roberts, Percy Colton, . .	North Amherst.
Rowe, Henry Simpson, . .	South Deerfield.
Stedman, Benjamin, . . .	Chicopee.
Tisdale, Charles Ernest, . .	North Amherst.
Total, ...	23

Graduate Course.

For Degree of M.S.

Carpenter, Malcolm Austin (B.Sc. 1891), ...	Leyden.	
Mossman, Frederick Way (B.Sc. 1890), ...	Westminster.	
Smith, Frederic Jason (B.Sc. 1890), ...	North Hadley.	
Smith, Ralph Eliot (B.Sc. 1894), ...	Newton Centre.	
Total, ...		4

Resident Graduates at the College and Experiment Stations.

Arnold, B.Sc., Frank Luman (Boston Univ.), . . .	Belchertown.	
Crocker, B.Sc., Charles Stoughton (Boston Univ.), . .	Sunderland.	
Haskins, B.Sc., Henry Darwin (Boston Univ.), . . .	North Amherst.	
Holland, B.Sc., Edward Bertram (Boston Univ.), . . .	Amherst.	
Johnson, B.Sc., Charles Henry (Boston Univ.), . . .	Prescott.	
Jones, B.Sc., Charles Howland (Boston Univ.), . . .	Downer's Grove, Ill.	
Lindsey, Ph.D., Joseph Bridgeo (Goettingen), . . .	Amherst.	
Pomeroy, B.Sc., Robert Ferdinand (Boston Univ.), . .	South Worthington.	
Shepardson, B.Sc., William Martin (Boston Univ.), . .	Warwick.	
Smith, B.Sc., Robert Hyde (Boston Univ.), ...	Amherst.	
Thomson, B.Sc., Henry Martin (Boston Univ.), . . .	Monterey.	
Total, ...		11

Summary.

Graduate course: —		
For degree of M.S.,	4	
Four-years course: —		
Graduates of 1894,	34	
Senior class,	31	
Junior class,	34	
Sophomore class,	33	
Freshman class,	16	
Two-years course: —		
Second year,	20	
First year,	23	
Resident graduates,	11	
Total,		206

FOUR-YEARS COURSE OF STUDY.

FRESHMAN YEAR.

	Agriculture.	Botany and Horticulture.	Chemistry.	Natural History.	Mathematics.	Latin and English.	French and Social Science.	Drawing and Military.
Fall, .	- - -	Botany, structural, — 5.	- - -	- - -	Advanced algebra, — 5. Book-keeping, — 2.	Latin, — 4. English, — 2.	- -	Study of tactics, — 1.
Winter, .	History of agriculture, soils and soil formation, — 4.	- - -	- - -	- - -	Geometry (plane), — 4.	Latin, — 4. English, — 2.	- -	Free-hand drawing, — 6.
Summer, .	Soils: — characteristics, improvement of, drainage, etc., — 4.	Botany, analytical, — 4.	Lectures in elementary chemistry, — 3.	- - -	Geometry (solid), and Advanced algebra, — 3.	Latin, — 3. English, — 2.	- -	- -
SOPHOMORE YEAR.								
Fall, .	Irrigation, disposition of sewage, manures and fertilizers, — 4.	Botany, economic, and laboratory work, — 4.	Lectures in elementary chemistry, — 4.	- - -	Trigonometry, — 3.	English, — 2.	French, — 4.	- -
Winter, .	- - -	Laboratory work, — 4.	Lectures and Practice, — 4.	Anatomy and physiology, — 4.	Mensuration, — 2.	English, — 2.	French, — 4.	Mechanical drawing, — 5.
Summer, .	Relations of the atmosphere to plant-life, mowings, pastures, grasses, ensilage, — 5.	Horticulture, — 5.	Dry and humid qualitative analysis, — 3.	- - -	Surveying, — 4.	English, — 2.	French, — 3.	- -

JUNIOR YEAR.

	Agriculture.	Botany and Horticulture.	Chemistry.	Zoölogy.	Mathematics.	Latin and English.	French and Social Science.	Drawing and Military.
Fall, .	Field crops, seed raising, production and improvement of varieties, machines and implements, — 4.	Market gardening, — 3.	Qualitative analysis, — 5.	Zoölogy, laboratory work, — 8.	- -	Rhetoric and composition, — 4.	- -	- -
Winter, .	Breeds and breeding of live stock, poultry farming, — 2.	- - -	Lectures and practice in organic chemistry, — 6.	Zoölogy, — 3.	Mechanics, — 5.	- -	English literature, — 4.	Drawing, — 2.
Summer, .	- - -	Landscape gardening, — 5.	The same continued, — 5.	Entomology, — 6.	Physics, — 4.	English, — 2.	- -	- -

* SENIOR YEAR (ELECTIVE).

Fall, .	Dairy farming, — 5.	Botany, cryptogamic, — 8.	Chemical physics and quantitative analysis, — 8.	Entomology, — 8. Veterinary science, — 5.	Electricity, — 5. Mathematics, — 5.	English, — 2.	Political economy, — 5. German, — 5.	Military science, — 1.
Winter, .	Cattle feeding, — 5.	Botany, cryptogamic, — 8.	Advanced work, with lectures, — 8.	Entomology, — 8. Veterinary science, — 5.	Electricity, — 5. Mathematics, — 5.	English, — 2.	Political economy, — 5. German, — 5.	Military science, — 1. Law lectures, — 1.
Summer, .	Experimental work in agriculture, — 5.	Botany, Physiological, — 8.	The same continued, — 8.	Entomology, — 8. Veterinary science, — 5.	Electricity, — 5. Mathematics, — 5.	English, — 2.	Constitutional history, — 5. German, — 5.	Military science, — 1.

* English and military science are required; of the other studies three at least must be chosen.

TWO-YEARS COURSE OF STUDY.

FIRST YEAR.

	Agriculture.	Botany and Horticulture.	Chemistry.	Mathematics.	English.	Zoölogy.	Drawing and Military.
Fall, .	Soils, drainage, irrigation, — 5.	Structural botany, — 3.	– – –	Commercial arithmetic, — 4.	English grammar, — 3.	– –	Study of tactics, — 1. Drawing, — 6.
Winter, .	Manures, fertilizers and their use, — 3.	Horticulture and greenhouse work, — 5.	Elementary chemistry, lectures, — 3. Laboratory work, — 4.	Algebra, — 5.	English grammar, — 3.	– –	– –
Summer, .	Farm implements and machinery, — 3.	Economic botany, — 4. Fruit culture, — 5.	Elementary chemistry, lectures, — 3.	Algebra and geometry, — 3.	Composition and rhetoric, — 3.	– –	– –

SECOND YEAR.

	Agriculture.	Botany and Horticulture.	Chemistry.	Mathematics.	English.	Zoölogy.	Drawing and Military.
Fall, .	Field crops, farm accounts, — 3.	Market gardening, and landscape gardening, — 5.	Chemistry of the farm, lectures, — 3.	Geometry and mensuration, — 3.	Composition and rhetoric, — 3.	Zoölogy and physiology, — 5.	– –
Winter, .	Live stock, breeds and breeding, — 4.	Forestry and greenhouse work, — 4.	Practice in agricultural chemical analysis, laboratory work, — 4.	Geometry and mensuration, — 2.	Composition and rhetoric, — 3.	Veterinary, — 5.	– –
Summer, .	Cattle feeding and dairying, — 3.	– – –	– – –	Surveying, — 4.	Composition and rhetoric, — 3.	Veterinary, — 5. Entomology, — 6.	– –

TWO-YEARS COURSE.

Agriculture. — Lecture and text-book work in the study of soils, formation, composition and physical character; tillage; drainage; irrigation; manures and fertilizers; farm implements and machinery, and their use; field crops, grasses and forage plants; ensilage; mowings; pastures; farm buildings; roads and fences; the breeds of cattle, sheep, horses and swine; stock breeding and feeding; dairy farming; poultry farming; markets and marketing. The work will be made as practical as possible, and will be continually illustrated in field, barns, dairy and laboratory. Many of the lectures will be of the nature of outdoor talks. Practical training will be given when needed or desired. Time allotted, two hundred and twenty-two hours.

Botany. — Elementary botany, to impart general knowledge of the structure of seeds and plants, methods of reproduction and propagation, hybridization, methods of analysis of agricultural plants, especially grasses and weeds; plant diseases, and peculiarities of plants of economical importance. Herbarium of plants of agricultural importance to be required. Time allotted, one hundred and thirty hours.

Chemistry. — Elementary chemistry; principles of the science; chemical physics; chemistry of elements important to the farmer; chemistry of soils, plants, animals, foods and fertilizers. Time allotted, one hundred and fifty hours.

English. — Thorough drill in principles of English grammar and rhetoric, with exercises in writing. Time allotted, two hundred and eleven hours.

Horticulture, Floriculture and Forestry. — Time allotted, one hundred and eighty-five hours.

Latin. — Elective. Designed for those intending to enter the four-years course.

Mathematics. — Commercial arithmetic; algebra, through quadratics; plane geometry; mensuration, including the solution of plane triangles; plane surveying, including topography, location and construction of roads. Time allotted: class-room, two hundred and thirty hours; field work, forty-five hours; drawing, ninety hours.

Physiology, Zoölogy and Entomology. — Time allotted, one hundred and thirty hours.

Veterinary Science. — Comparative anatomy and physiology; hygiene; treatment of emergency cases; diagnosis and treatment of simple cases. Time allotted, one hundred and eleven hours.

GRADUATE COURSE.

1. No honorary degrees shall be conferred.

2. No applicant shall be eligible to the degree of M.S. until he has received the degree of B.S. or its equivalent.

3. The faculty shall offer a course of study in each of the following subjects: mathematics and physics; chemistry; agriculture; botany; horticulture; entomology; veterinary. Upon the satisfactory completion of any two of these, the applicant shall receive the degree of M.S. This prescribed work may be done in the Massachusetts Agricultural College or at any institution that the applicant may choose; but in either case the degree shall be conferred only after the applicant has passed an examination at the college under such rules and regulations as may be prescribed.

4. Every student in the graduate course shall pay one hundred dollars to the treasurer of the college before receiving the degree of M.S.

TEXT-BOOKS.

WOOD — "The American Botanist and Florist."
BESSEY — "Botany for High Schools and Colleges."
GRAY — "Manual."
GRAY — "Structural Botany."
BOWER — "Practical Botany."
ARTHUR BARNES and COULTER — "Plant Dissection."
CAMPBELL — "Structural and Systematic Botany."
OEL — "Experimental Plant Physiology."
GOODALE — "Physiological Botany."
DARWIN and ACTON — "Practical Physiology of Plants."
SCRIBNER — "Fungous Diseases of the Grapevine."
VASEY — "Agricultural Grasses of the United States."
SMITH — "Diseases of Garden Crops."
WOLLE — "Fresh-Water Algæ."
LONG — "How to Make the Garden Pay."
LONG — "Ornamental Gardening for Americans."
TAFT — "Green-house Construction."
WEED — "Insects and Insecticides."
WEED — "Fungi and Fungicides."
FULLER — "Practical Forestry."
MAYNARD — "Practical Fruit Grower."
McALPINE — "How to know Grasses by their Leaves."
MORTON — "Soil of the Farm."
GREGORY — "Fertilizers."
MILLS and SHAW — "Public School Agriculture."
MILES — "Stock Breeding."

ARMSBY — "Manual of Cattle Feeding."
CURTIS — "Horses, Cattle, Sheep and Swine."
MORROW and HUNT — "Soils and Crops."
GROTENFELD — "The Principles of Modern Dairy Practice."
SHEPARD — "Elementary Chemistry."
STORER — "Agriculture in its Relations to Chemistry."
RICHTER and SMITH — "Text-book of Inorganic Chemistry."
MUTER — "Analytical Chemistry."
ROSCOE — "Lessons in Elementary Chemistry."
BERNTHSEN and McGOWAN — "Text-book of Organic Chemistry."
FRESENIUS — "Qualitative Chemical Analysis."
FRESENIUS — "Quantitative Chemical Analysis."
REYNOLDS — "Experimental Chemistry."
SUTTON — "Volumetric Analysis"
DANA — "Manual of Mineralogy and Lithology."
BRUSH — "Manual of Determinative Mineralogy."
MILNE — "High School Algebra."
WELLS — "College Algebra."
DANA — "Mechanics."
WELLS — "Plane and Solid Geometry" (revised edition).
DAVIES — "Surveying."
WARNER — "Mensuration."
WELLS — "Essentials of Trigonometry."
LOOMIS — "Analytical Geometry."
LOOMIS — "Differential and Integral Calculus."
JONES — "Sound, Light and Heat."
THOMPSON — "Electricity and Magnetism."
AYRTON — "Practical Electricity."
LOOMIS — "Meteorology."
MARTIN — "Human Body" (elementary course).
MARTIN — "Human Body" (briefer course).
WALKER — "Political Economy" (abridged edition).
GIDE — "Principles of Political Economy."
WILSON — "The State, Historical and Practical Politics."
WHITNEY and LOCKWOOD — "English Grammar."
LOCKWOOD — "Lessons in English."
GENUNG — "Outlines of Rhetoric."
SPRAGUE — "Six Selections from Irving's Sketch-book."
WHITTIER, No. 4; LONGFELLOW, Nos. 33, 34, 35; LOWELL, No. 39 — "Riverside Literature Series."
HUDSON — "Selections of Prose and Poetry." WEBSTER, BURKE, ADDISON, GOLDSMITH, SHAKESPEARE.
GILMAN — "English Literature."
WHITNEY — "French Grammar."
LUQUIENS — "Popular Science."
WHITNEY — "German Grammar."
BOISEN — "Preparatory German Prose."
BERNHARDT — "Sprach-und Lesebuch."
HODGES — "Scientific German."

CÆSAR — "The Invasion of Britain."
CÆSAR — "Gallic War."
NEPOS — "Selections Illustrative of Greek and Roman History."
WHITE — "Progressive Art Studies."
FAUNCE — "Mechanical Drawing."
U. S. ARMY — "Infantry Drill Regulations"
U. S. ARMY — "Artillery Drill Regulations."

To give not only a practical, but a liberal education is the aim in each department, and the several courses have been so arranged as to best subserve that end. Weekly exercises in composition and declamation are held throughout the course. The instruction in agriculture and horticulture is both theoretical and practical. A certain amount of labor is required of each student, and the lessons of the recitation room are practically enforced in the garden and field. Students are allowed to work for wages during such leisure hours as are at their disposal. Under the act by which the college was founded, instruction in military tactics is imperative, and each student, unless physically debarred,* is required to attend such exercises as are prescribed, under the direction of a regular army officer stationed at the college.

FOUR-YEARS COURSE.

ADMISSION.

Candidates for admission to the freshman class will be examined, orally and in writing, upon the following subjects: English grammar, geography, United States history, physiology, physical geography, arithmetic, the metric system, algebra (through quadratics), geometry (two books), civil government (Mowry's "Studies in Civil Government"), and Latin (grammar and first ten chapters of the first book of Cæsar's "Gallic War"), or an equivalent. The standard required is 65 per cent on each paper. Diplomas from high schools will *not* be received in place of examination. Examination in the following subjects may be taken a year before the candidate expects to enter college: English grammar, geography, United States history, physical geography and physiology. Satisfactory examination in a substantial part of the subjects offered will be required, that the applicant may have credit for this preliminary examination.

Candidates for higher standing are examined as above, and also in the studies gone over by the class to which they desire admission.

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* Certificates of disability must be procured of Dr. Herbert B. Perry of Amherst.

No one can be admitted to the college until he is sixteen years of age. The regular examinations for admission are held at the Botanic Museum, at 9 o'clock A.M., on Thursday and Friday, June 20 and 21, and on Tuesday and Wednesday, September 3 and 4; but candidates may be examined and admitted at any other time in the year. For the accommodation of those living in the eastern part of the State, examinations will also be held at 9 o'clock A.M., on Thursday and Friday, June 20 and 21, at Jacob Sleeper Hall, Boston University, 12 Somerset Street, Boston; and for the accommodation of those in the western part of the State, at the same date and time, at the Sedgwick Institute, Great Barrington, by James Bird. Two full days are required for examination, and candidates must come prepared to stay that length of time.

TWO-YEARS COURSE.

Calendar the same as in the four-years course. Age for admission, fifteen years. The objects of this course are, primarily, to help farmers' sons and others, proposing to follow some branch of agriculture, who lack either the time or the means required for the longer course; secondly, in so far as practicable, to serve as a preparation for the regular college course. Date of examination, same as for four-years course.

Admission.

Candidates for admission are examined, orally and in writing, in English grammar, geography, arithmetic and United States history. The standard required is 65 per cent on each paper.

ENTRANCE EXAMINATION PAPERS USED IN 1894.

Four-years Course.

Arithmetic.

Note. — The work and answers of all problems are required.

1. What is a prime number, a composite number? Give examples of each.
2. Find the least common multiple of 36, 56, 75, and 72.
3. Write a proper fraction, an improper fraction, and give the rules for the addition and division of fractions.
4. At $21 per ton, what is the cost of 2,560 pounds of hay?
5. What is the value of a pile of wood 100 feet long, $4\frac{1}{2}$ feet high and $12\frac{1}{2}$ feet wide, at $5 per cord?

6. Bought a horse for \$250, paid for keeping \$10 and sold him for \$234: what was the loss per cent?

7. Find the amount of \$575 for 2 years, 6 months and 15 days, at $6\frac{1}{3}$ per cent.

8. What is the bank discount and proceeds of a note for \$500, for 90 days, at 6 per cent.?

9. If 2 men can build 803 rods of fence in 22 days, how long will it take them to build 73 rods?

10. What must be paid in Boston for a draft of \$2,000 on Philadelphia, at 30 days, when exchange is at 2 per cent premium?

Metric System.

NOTE. — The work and answers of all problems are required.

1. Name the principal units of the metric system, and give their equivalents.

2. How are the lower denominations of each weight, or measure, expressed? The higher denominations?

3. Change to meters, and add 114.5 decameters, 425 hectometers and 950.5 centimeters.

4. At \$1.10 per cubic meter, what will it cost to dig a trench 2 kilometers and 75.5 meters long, 2.5 meters wide and 1.5 meters deep?

5. In 40 metric tons, how many tons?

6. What must be the width of a bin 2 meters long and 2 meters deep to contain 5,000 liters of grain?

7. Change 2 bushels, 7 quarts, 2 pints, to liters.

8. In 3 lbs. 8 oz 18 pwt. of gold, how many grams?

9. How many miles in $45\frac{1}{2}$ kilometers?

10. Write the table for long measure.

Algebra.

NOTE. — The work and answers of all problems are required.

1. Define coefficient, exponent, and write four axioms.

2. Resolve into prime factors $(15 - 2x - x^2)$, $(x^2 - 14x + 45)$.

3. Name three methods of elimination and solve: —

$$\left\{ \begin{array}{l} \frac{x+y}{3} + \frac{y-x}{2} = 9 \\ \frac{x}{2} + \frac{x+y}{9} = 5 \end{array} \right\}$$

4. Find the cube root of $x^6 + 1 - 6x - 6x^5 + 15x^2 + 15x^4 - 20x^3$.

5. Divide $9x - 12x - \frac{1}{2} - 2 + 4x - \frac{1}{2} + x - 1$ by $3x - \frac{1}{2} - 2 - x - \frac{1}{2}$.

6. Simplify the following expression: —

$$\sqrt[3]{54} + \sqrt{\tfrac{1}{2}} - \sqrt[3]{250} - \tfrac{3}{4}\sqrt{\tfrac{2}{9}}$$

7. Solve $\sqrt{2x-3} - \sqrt{8x+1} + \sqrt{18x-92} = 0$.

8. Write a pure quadratic equation, and solve

$$(x^2 - 5x)^2 - 8(x^2 - 5x) = 84.$$

9. Solve $2x^2 + 3x - 5\sqrt{2x^2+3x+9} = -3$.

10. Solve $\left\{\begin{array}{l} x^3 - y^3 = 117 \\ x - y = 3 \end{array}\right\}$.

Geometry.

1. Define geometry, theorem, postulate, corollary, scholium.

2. Draw an acute angle, obtuse angle, a right angle.

Prove the following propositions: —

3. If two straight lines intersect each other, the vertical angles are equal.

4. If two parallel lines are cut by a third straight line, the alternate interior angles are equal.

5. Two angles whose sides are parallel each to each are either equal or supplementary.

6. Any point in the bisector of an angle is equally distant from the sides of the angle.

7. Define and draw a trapezium, trapezoid, rhomboid and rhombus.

8. If the opposite sides of a quadrilateral are equal, the figure is a parallelogram.

9. The diagonals of a parallelogram bisect each other.

10. The sum of the angles of any polygon is equal to two right angles taken as many times as the figure has sides, less two.

English Grammar and Composition.

NOTE. — Penmanship, spelling, capitalization and punctuation will be considered in determining the excellence of your paper.

1. Define language, grammar, composition.

2. Name and define the four parts into which English grammar is divided.

3. Write a simple sentence, a compound sentence, a complex sentence. Analyze the complex sentence.

4. Give the plurals of the following, and indicate the possessives (of both singular and plural): mother-in-law, ox, spoonful, beau, seraph, staff, maid, hogshead, phenomenon, sheep.

5. Name the personal pronouns, the relative pronouns, the demonstrative pronouns.

6. Give principal parts of put, hang, go, lie, lay, sit, set, eat, spar, blow.

7. Fill the blanks correctly with *shall* or *will:* —

(*a*) If I stay, I —— be late.

(*b*) You —— obey me. It —— make you happier in the end.

(*c*) It —— give me much pleasure to meet you there, and I —— not forget the date.

8. Correct the following, stating reasons : —

(*a*) John don't understand those kind of books.

(*b*) I should like to have gone to the circus.

(*c*) He is the squarest man I ever see.

(*d*) He ain't no good, nohow. It beats the dickens how he has got such a love for base ball.

(*e*) He travels everywheres. It seems queer to you and I that he hadn't ought to get tired.

9. Change the following to connected prose : —

> Long lines of cliff breaking have left a chasm;
> And in the chasm are foam and yellow sands;
> Beyond, red roofs about a narrow wharf
> In cluster; then a moulder'd church; and higher
> A long street climbs to one tall tower'd mill;
> And high in heaven behind it a gray down
> With Danish barrows; and a hazel wood,
> By autumn nutters haunted, flourishes
> Green in a cuplike hollow of the down.

10. Write an exercise of at least two hundred words upon one of the subjects named below : —

(*a*) A description of my last school.

(*b*) President Cleveland.

(*c*) Washington Irving.

(*d*) Abraham Lincoln.

(*e*) The farmer's place in the nation.

Geography.

Note. — Penmanship, spelling, capitalization and punctuation will be considered in determining the excellence of your paper.

1. What is geography? What is the shape of the earth? Give two proofs of the correctness of your answer.

2. Name the political divisions of North America. Name and locate three prominent peninsulas of North America.

3. Bound the United States. Name the States bordering on the Pacific Ocean; those bordering on the Gulf of Mexico.

4. Describe briefly the Mississippi Valley and its productions.

5. What important canals pertain to the commerce of the United States? What is a canal? Name five important railroads, and tell what places they connect.

6. Write a brief description of New England, contrasting it with the Middle States.

7. For what are the following States remarkable: Virginia, Minnesota, Nevada, California, Texas, Pennsylvania?

8. What divisions of Europe are in the same latitude as is Boston?

9. Describe four important rivers of Africa. What divisions of South America are crossed by the equator? what divisions of Africa?

10. Name the chief ports of Europe on the Mediterranean Sea. In what country, and on or near what water, are the following: Paris, Quebec, Milwaukee, Omaha, Calcutta, Tokio, Amsterdam, Naples, Liverpool, Rio Janeiro?

United States History.

NOTE. — Penmanship, spelling, capitalization and punctuation will be considered in determining the excellence of your paper.

1. What European nations made permanent settlements within the present limits of the United States, and where?

2. Give a brief account of the Plymouth Colony and of the Massachusetts Bay Colony.

3. Write what you know of Sir Walter Raleigh.

4. What was the cause and what were the effects of the French and Indian War?

5. Write a brief sketch of Benjamin Franklin.

6. Write an account of that battle of the Revolutionary War which you regard the most important.

7. Describe the visit of Lafayette to this country. Why was this an event of importance?

8. Explain as clearly as you can "The Fugitive Slave Law." What is meant by the "Reconstruction Policy" after the Civil War?

9. What important event in the United States History is to be associated with each of the following: Trenton, New Orleans, Jamestown, Cambridge, Saratoga, Chicago, Washington, Long Island, Fort Ticonderoga, Boston?

10. State clearly the three causes that, in your opinion, have been most powerful in effecting the *material* progress of the United States.

Physical Geography.

Note. — Penmanship, spelling, capitalization and punctuation will be considered in determining the excellence of your paper.

1. Of what does physical geography treat?

2. Define the following: a plateau, a volcano, a sierra, a water-shed, a delta, monsoons.

3. Explain the difference between a peninsula and a cape; between a prairie and a selva.

4. Define the atmosphere. How is it warmed? What makes the trade-winds important? In what directions do they blow? Account for this.

5. Define climate. State and illustrate the effect of ocean currents on climate.

6. How are fog and rain produced? How is snow produced? How is hail produced? How are the "weather probabilities" arrived at, and of what value is their daily announcement?

7. How do plants differ from inorganic matter? How do you account for the luxuriant vegetation of the torrid zone?

8. What trees are found in the higher latitudes? What is the effect of elevation on plant life? What have you ever observed in proof of this?

9. Show how the animal kingdom is dependent on the vegetable. By what is the distribution of animals over the earth's surface regulated?

Physiology.

1. Define physiology, anatomy, hygiene.
2. What is the skeleton and what are its uses?
3. Name three uses of food.
4. Describe the heart. What is the use of blood?
5. Why do we breathe? Name the organs of respiration.
6. What is excretion? What constitutes bodily waste? What organs are concerned in excretion?
7. What uses has the nervous system?
8. Name the special senses and the organs connected with each.
9. Give injurious effects from use of tobacco.
10. Is the use of alcoholic beverages beneficial or detrimental? Why?

Civil Government.

Note. — Penmanship, spelling, capitalization and punctuation will be considered in determining the excellence of your paper.

1. Define the following: monarchy, aristocracy, democracy. How does a republic differ from a democracy?

2. What three kinds of colonial governments were there in our country? Name the colonies that were under each.

3. When did the colonies become States? Write in full the names of the thirteen original States.

4. In what year and where did the first Continental Congress meet? the second Continental Congress? How long did this Congress continue its sessions?

5. What were the Articles of Confederation? In what year did the constitutional form of government go into effect? Where was the first President inaugurated?

6. Into what departments is the government of the United States divided? Name at least two qualifications for the office of President.

7. What two bodies constitute the Congress? Of how many members does the United States Senate now consist? How many Representatives in Congress has Massachusetts? In which Congressional district do you reside, and who is your Representative in Congress?

8. Name three of the principal officers of the town or city in which you live, and the duty of each. Name two of the principal officers of the county in which you live, and the duty of each.

9. In what bodies is the legislative power of the State vested?

10. What is the title of the chief executive officer of the State of Massachusetts? What is his name?

Cæsar's Gallic War.

NOTE. — Translate into grammatical English. Make your sentences complete. Spelling, capitalization and punctuation will be considered in determining the excellence of your paper.

1. Translate: —

Interea eâ legione, quam secum habebat, militibusque qui ea provinciâ convenerant, a lacu Lemanno, qui in flumen Rhodanum influit, ad montem Juram, qui fines Sequanorum ab Helvetiis dividit, millia passuum decem novem murum, in altitudinem pedum sedecim, fossamque perducit. Eo opere perfecto praesidia disponit, castella communit, quo facilius, si se invito transire conarentur, prohibere possit. Ubi ea dies, quam constituerat cum legatis, venit, et legati ad eum reverterunt, negat se more et exemplo populi Romani posse iter ulli per provinciam dare, et, si vim facere conentur, prohibiturum ostendit.

2. How many declensions of nouns in Latin? Decline *murum*, *pedum*, *fossam*, and any noun of the fourth declension found in the first sentence.

3. Name the pronouns found in the first sentence, and tell the class to which each belongs.

4. How many conjugations of verbs in Latin, and how are they distinguished? What is a deponent verb? Name any deponent verb found in the passage.

5. Write principal parts, active and passive voices of *habebat*, *disponit*, *negat*, *communit*. Write the active infinitives of these verbs.

6. In which case are the following, and why: *legione*, *passuum*, *opere*, *more*, *ulli?*

DEGREES.

Those who complete the four-years course receive the degree of Bachelor of Science, the diploma being signed by the governor of Massachusetts, who is president of the corporation.

Regular students of the college may also, on application, become members of Boston University, and upon graduation receive its diploma in addition to that of the college, thereby becoming entitled to all the privileges of its alumni.

A certificate signed by the president of the college will be awarded to those completing the two-years course, the same to go into effect 1897. Those completing the graduate course receive the degree of Master of Science.

EXPENSES.

Tuition in advance: —			
Fall term,	$30 00		
Winter term,	25 00		
Summer term,	25 00		
		$80 00	$80 00
Room rent, in advance, $8 to $16 per term,		24 00	48 00
Board, $2.50 to $5 per week,		95 00	190 00
Fuel, $5 to $15,		5 00	15 00
Washing, 30 to 60 cents per week,		11 40	22 80
Military suit,		15 75	15 75
Expenses per year,		$231 15	$371 55

Board in clubs has been about $2.45 per week; in private families, $4 to $5. The military suit must be obtained immediately upon entrance at college, and used in the drill exercises prescribed. The following fees will be charged for the main-

tenance of the several laboratories: chemical, $10 per term used; zoölogical, $4 per term used; botanical, $1 per term used by sophomore class, $2 per term used by senior class; entomological, $2 per term used. Some expense will also be incurred for lights and text-books. Students whose homes are within the State of Massachusetts can in most cases obtain a scholarship by applying to the senator of the district in which they live.

THE LABOR FUND.

The object of this fund is to assist those students who are dependent either wholly or in part on their own exertions, by furnishing them work in the several departments of the college. The greatest opportunity for such work is found in the agricultural and horticultural departments. Application should be made to Profs. William P. Brooks and Samuel T. Maynard, respectively, in charge of said departments. Students desiring to avail themselves of its benefits must bring a certificate signed by one of the selectmen of the town in which they are resident, certifying to the fact that they require aid.

ROOMS.

All students, except those living with parents or guardians, will be required to occupy rooms in the college dormitories.

For the information of those desiring to carpet their rooms, the following measurements are given: In the new south dormitory the study rooms are about fifteen by fourteen feet, with a recess seven feet four inches by three feet; and the bedrooms are eleven feet two inches by eight feet five inches. This building is heated by steam. In the north dormitory the corner rooms are fourteen by fifteen feet, and the annexed bedrooms eight by ten feet. The inside rooms are thirteen and one-half feet by fourteen and one-half feet, and the bedrooms eight by eight feet. A coal stove is furnished with each room. Aside from this, all rooms are unfurnished. Mr. Thomas Canavan has the general superintendence of the dormitories, and all correspondence relative to the engaging of rooms should be with him.

SCHOLARSHIPS.

Established by Private Individuals.

Mary Robinson Fund of one thousand dollars, the bequest of Miss Mary Robinson of Medfield.

Whiting Street Fund of one thousand dollars, the bequest of Whiting Street, Esq., of Northampton.

Henry Gassett Fund of one thousand dollars, the bequest of Henry Gassett, Esq., of North Weymouth.

The income of the above funds is assigned by the faculty to worthy students requiring aid.

CONGRESSIONAL SCHOLARSHIPS.

The trustees voted in January, 1878, to establish one free scholarship for each of the congressional districts of the State. Application for such scholarships should be made to the Representative from the district to which the applicant belongs. The selection for these scholarships will be determined as each member of Congress may prefer; but, where several applications are sent in from the same district, a competitive examination would seem to be desirable. Applicants should be good scholars, of vigorous constitution, and should enter college with the intention of remaining through the course, and then engaging in some pursuit connected with agriculture.

STATE SCHOLARSHIPS.

The Legislature of 1883 passed the following resolve in favor of the Massachusetts Agricultural College: —

Resolved, That there shall be paid annually, for the term of four years, from the treasury of the Commonwealth to the treasurer of the Massachusetts Agricultural College, the sum of ten thousand dollars, to enable the trustees of said college to provide for the students of said institution the theoretical and practical education required by its charter and the law of the United States relating thereto.

Resolved, That annually, for the term of four years, eighty free scholarships be and hereby are established at the Massachusetts Agricultural College, the same to be given by appointment to persons in this Commonwealth, after a competitive examination, under rules prescribed by the president of the college, at such time and place as the senator then in office from each district shall designate; and the said scholarships shall be assigned equally to each senatorial district. But, if there shall be less than two successful applicants for scholarships from any senatorial district, such scholarships may be distributed by the president of the college equally among the other districts, as nearly as possible; but no applicant shall be entitled to a scholarship unless he shall pass an examination in accordance with the rules to be established as hereinbefore provided.

The Legislature of 1886 passed the following resolve, making perpetual the scholarships established : —

Resolved, That annually the scholarships established by chapter forty-six of the resolves of the year eighteen hundred and eighty-three be given and continued in accordance with the provisions of said chapter.

In accordance with these resolves, any one desiring admission to the college can apply to the senator of his district for a scholarship. Blank forms of application will be furnished by the president.

EQUIPMENT.

Agricultural Department.

The Farm. — Among the various means through which instruction in agriculture is given, none exceeds in importance the farm. The part which is directly under the charge of the professor of agriculture comprises about one hundred and fifty acres of improved land and thirty acres of woodland. Of the improved land, about thirty acres are kept permanently in grass, and managed partly with a view to landscape effect. A considerable share of this land is, however, laid off in half and quarter acre plats, and variously fertilized with farm-yard and stable manures and chemicals, with a view to throwing light upon the economical production of grass. These plats are staked and labelled, so that all may see exactly what is being used and what are the results.

The rest of the farm is managed under a system of rotation, all parts being alternately in grass and hoed crops. All the ordinary crops of this section are grown, and many not usually seen upon Massachusetts farms find a place here. Our large stock of milch cows being fed almost entirely in the barn, fodder crops occupy a prominent place. Experiments of various kinds are continually under trial; and every plat is staked and bears a label stating variety under cultivation, date of planting and manures and fertilizers used.

Methods of land improvement are constantly illustrated here, tile drainage especially receiving a large share of attention. There are now some nine miles of tile drains in successful and very satisfactory operation upon the farm. Methods of clearing land of stumps are also illustrated, a large amount of such work having been carried on during the last few years.

In all the work of the farm the students are freely employed, and classes are frequently taken into the fields; and to the lessons

to be derived from these fields the students are constantly referred.

The Barn and Stock. — Our commodious barns contain a large stock of milch cows, many of which are grades ; but the following pure breeds are represented by good animals, viz., Holstein-Friesian, Ayrshire, Jersey, Guernsey and Shorthorn. Experiments in feeding for milk and butter are continually in progress. We have a fine flock of Southdown sheep and a few choice specimens of the Shropshire, Horned Dorset, Cotswold and Merino breeds. Swine are represented by the Chester White, Poland China, Middle Yorkshire and Tamworth breeds. Besides work horses, we have a number of pure-bred Percherons, used for breeding as well as for work. It is the intention also to keep a stallion of one of the coaching breeds.

The barn, more fully described elsewhere in this report, is a model of convenience and labor-saving arrangements. It illustrates different methods of fastening animals, various styles of mangers, watering devices, etc. Connected with it are a plant for electric light and power, commodious storage rooms for vehicles and machines. It contains silos and a granary. A very large share of the work in the barn is performed by students, and whenever points require illustration, classes are taken to it for that purpose.

Dairy School. — Connected with the barn is a wing which is to accommodate both practical and educational work in dairying. The wing contains one room for heavy dairy machinery, another for lighter machinery, both large enough to accommodate various styles of all prominent machines ; a large ice house, a cold-storage room, a room for raising cream by gravity methods, a class-room and a laboratory. The power used is an electric motor. This department is steam heated and piped for hot and cold water and steam. It is proposed to place in this department a full line of modern dairy machinery, so that we shall be able to illustrate all the various processes connected with the creaming of milk, the preparation of milk for market and the manufacture of butter. Special instruction in such work will be offered after Sept. 1, 1895.

Equipment of Farm. — Aside from machines and implements generally found upon farms, the more important of those used upon our farm and in our barn which it seems desirable to mention are the following : reversible sulky plough, broadcast fertilizer distributor, manure spreader, grain drill, horse corn planter, potato planter, wheelbarrow grass seeder, hay loader, potato digger, hay press, fodder cutter and crusher and grain mill. It is our aim

to try all novelties as they come out, and to illustrate everywhere the latest and best methods of doing farm work.

Lecture Room. — The agricultural lecture room in south college is well adapted to its uses. It is provided with numerous charts and lantern slides, illustrating the subjects taught. Connected with it are two small rooms at present used for the storage of illustrative material, which comprises soils in great variety, all important fertilizers and fertilizer materials, implements used in the agriculture of our own and other countries, and a collection of grasses and forage plants, grains, etc.

An important addition to our resources made during the past year consists of a full series of Landsberg's models of animals. These are accurate models of selected animals of all the leading breeds of cattle, horses, sheep and swine, and from one-sixth to full size, according to subject. We are provided with a complete collection of seeds of all our common grasses and the weeds which grow in mowings, and have also a large collection of the concentrated food stuffs. All these are continually used in illustration of subjects studied.

Museum. — An important beginning has been made towards accumulating materials for an agricultural museum. This is to contain the rocks from which soils have been derived, soils, fertilizer materials and manufactured fertilizers, seeds, plants and their products, stuffed animals, machines and implements. It is expected to make this collection of historical importance by including in it old types of machines and implements, earlier forms of breeds, etc. For lack of room the material thus far accumulated, which is considerable, is stored in a number of scattered localities, and much of it where it cannot be satisfactorily exhibited.

Botanic Department.

The equipment of the botanic department has been collected for the two-fold purpose of supplementing instruction in the science of botany and in the various lines of horticultural work, as fruit culture, market gardening, forestry, floriculture and landscape gardening.

For teaching botany proper the equipment is as follows: —

The Botanic Museum, containing the Knowlton herbarium, of over ten thousand species of phanerogamous and the higher cryptogamous plants; about five thousand species of fungi, and several collections of lichens and mosses permanently mounted and systematically arranged for study and reference. It also contains a large collection of native woods, cut so as to show their indi-

vidual structure; numerous models of native fruits; specimens of abnormal and peculiar forms of stems, fruits, vegetables, etc.; many interesting specimens of unnatural growths of trees and plants, natural grafts, etc.; together with many specimens and models prepared for illustrating the growth and structure of plants, and including a model of the squash which raised by the expansive force of its growing cells the enormous weight of five thousand pounds.

During the past year considerable work has been done on the herbarium. A large number of valuable specimens which have been accumulating for many years have been labelled and mounted. About five thousand species of cryptogams have been mounted on half-size sheets, and in many instances it has been necessary to relabel them, so that they will conform to some standard work on classification and nomenclature. It is hoped that before the close of the present academic year these specimens will be enclosed in folios and placed on shelves in the most systematic and convenient manner for use. A few hundred flowering plants — largely western species — have also been added to the Knowlton herbarium. It is intended in the course of time to have the whole herbarium card-catalogued, so that it will be possible to see at a glance just what the collection contains.

As the phanerogamic collection is largely used as a reference one for the plants of our State, we think it should contain as complete a collection of the indigenous, naturalized and adventive species of the flowering plants of Massachusetts as is possible to obtain. By thus concentrating our energies on a small and eminently legitimate field, we can make this collection a complete and valuable one. There is ever an increasing number of new plants (adventive species) which spring up in different parts of our State every year, and it would be of considerable importance to have them all represented in the herbarium. These plants are candidates for admission, as it were, and if they become naturalized some of them are likely to prove undesirable emigrants. It is these naturalized species that constitute the greater bulk of our weeds which form such an unmitigated curse to the farmer, and there is no more proper place for the habits and methods of distribution of these plants to be studied than at the Agricultural College.

The cryptogamic collection, however, constitutes the most important one, especially the economic fungi, inasmuch as any work done in the line of vegetable pathology requires that this group should be well represented.

The department subscribes for all the leading American fungi exsiccati.

In the cryptogamic herbarium there are now about eleven hundred species of mosses and liverworts, and are mainly represented by Austin Denslow's and Frost's collections in this country, besides a very large number of British and European specimens from the Hunt and Müller collections.

The lichens collection contains the Tuckerman exsiccati, the Schaerer exsiccati, the Cummings and Seymour decades of North American lichens and the Müller Thüringenschen Staaten collection. The fungi are represented by Ellis and Everhart, North American fungi; Seymour and Earle, economic fungi; Shear's New York fungi; Arthur and Holway, Uredineæ exsiccatæ et icones; Kellerman and Swingle, Kansas fungi; Halstead's New England fungi; Cooke's Fungi Britannici; Ravenel, Fungi Caroliniani; Müller, Thüringinschen Staaten fassicles; and many specimens from the herbarium of Frost, the veteran botanist of the Connecticut valley.

The Botanic Lecture Room, in the same building, is provided with diagrams and charts of over three thousand figures, illustrating structural and systematic botany.

The Botanic Laboratory, with provision for twenty-five students to work at one time, is equipped with Leitz', Reichert's, Bausch and Lomb's, Beck's, Queen's and Tolles' compound microscopes, with objectives varying from four inch to one-fifteenth inch focal length, and also with a few dissecting microscopes. It also contains a DuBois Raymond induction apparatus, a Thoma and a Beck microtome, a self-registering thermometer, a Wortmann improved clinostat and also one of special construction, an Arthur centrifugal apparatus with electric motor, a Pfeffer-Baranetzky electrical self-registering auxanometer, a Sach's arc-auxanometer, a horizontal reading microscope (Pfeffer model), various kinds of dynamometers of special construction, respiration appliances, mercurial sap and vacuum gauges, manometers, gas and exhaust chambers, a Bausch and Lomb micro-photographic camera, a Clay landscape camera and dark closet fitted for work, besides various other appliances for work and demonstration in plant physiology. Special attention is here given to the study of the common and useful plants cultivated on the farm, in the garden and under glass; and in the senior year, the studies of which are elective, an extensive course is given in cryptogamic and physiological botany, with special reference to the study of fungous and other parasitic plant growths attacking our farm and garden crops.

Greenhouses. — To aid in the instruction of botany as well as that of floriculture and market gardening, the glass structures contain a large collection of plants of a botanical and economic

value, as well as those grown for commercial purposes. They consist of a large octagon, forty by forty feet, with sides twelve feet high and a central portion over twenty feet high, for the growth of large specimens, like palms, tree ferns, the bamboo, banana, guava, olive, etc.; a lower octagon, forty by forty feet, for general greenhouse plants; a moist stove, twenty-five by twenty-five feet; a dry stove, twenty-five by twenty-five feet, a rose room, twenty-five by twenty feet; a room for aquatic plants, twenty by twenty-five feet; a room for ferns, mosses and orchids, eighteen by thirty feet; a large propagating house, fifty by twenty-four feet, fitted up with benches sufficient in number to accommodate fifty students at work at one time; a vegetable house, forty-two by thirty-two feet; two propagating pits, eighteen by seventy-five feet, each divided into two sections for high and low temperatures, and piped for testing overhead and under-bench heating; a cold grapery, eighteen by twenty-five feet. To these glass structures are attached three workrooms, equipped with all kinds of tools for greenhouse work. In building these houses as many as possible of the principles of construction, heating and ventilating, etc., have been incorporated for the purposes of instruction.

For instruction in horticulture are: —

Orchards. — The orchards are extensive, and contain nearly all the valuable leading varieties, both old and new, of the large fruits, growing under various conditions of soil and exposure.

Small Fruits. — The small fruit plantations contain a large number of varieties of each kind, especially the new and promising ones, which are compared with older sorts, in plots and in field culture. Methods of planting, pruning, training, cultivation, study of varieties, gathering, packing and shipping fruit, etc., are taught by field exercises, the students doing a large part of the work of the department.

Nursery. — This contains more than five thousand trees, shrubs and vines, in various stages of growth, where the different methods of propagation by cuttings, layers, budding, grafting, pruning and training are practically taught to the students.

Garden. — All kinds of garden and farm-garden crops are grown in this department, furnishing ample illustration of the treatment of all market-garden crops. The income from the sales of trees, plants, flowers, fruit and vegetables aids materially in the support of the department, and furnishes illustrations of the methods of business, with which all students are expected to become familiar.

Forestry. — Many kinds of trees suitable for forest planting are

grown in the nursery, and plantations have been made upon the college grounds and upon private estates in the vicinity, affording good examples of this most important subject. A large forest grove is connected with this department, where the methods of pruning trees and the management and preservation of forests can be illustrated. In the museum and lecture room are collections of native woods, showing their natural condition and peculiarities; and there have been lately added the prepared wood sections of R. B. Hough, mounted on cards for class-room illustrations.

Ornamental trees, shrubs and flowering plants are grouped about the grounds in such a way as to afford as much instruction as possible in the art of landscape gardening. All these, as well as the varieties of large and small fruits, are marked with conspicuous labels, giving their common and Latin names, for the benefit of the students and the public.

Tool House. — A tool house, thirty by eighty feet, has just been completed, containing a general store-room for keeping small tools; a repair shop with forge, anvil and work bench; and a carpenter shop equipped with a large Sloyd bench and full set of tools. Under one-half of this building is a cellar for storing fruit and vegetables. In the loft is a chamber, thirty by eighty feet, for keeping the hot-bed sashes, shutters, mats, berry crates, baskets and other materials when not in use.

Connected with the stable is a cold-storage room, with an ice chamber over it, for preserving fruit, while the main cellar underneath the stable is devoted to the keeping of vegetables.

All the low land south of the greenhouses has been thoroughly underdrained and put into condition for the production of any garden or small fruit crop.

A Massachusetts Garden.

The proposition to devote the hillside in the south-east corner of the farm to the growth of the trees and plants of Massachusetts is one that should be carried out, thus adding a very useful as well as beautiful feature to the grounds.

The location of the college is one of the most beautiful to be found in the State, and the ornamentation of the banks of the beautiful sheet of water between the botanic department and the main college buildings, as well as the hillside above the greenhouses, will do more than any one thing to make the college grounds noted for their finished beauty as a combination of art and nature.

Zoölogical Department.

Zoölogical Lecture Room. — The room in south college is well adapted for lecture and recitation purposes, and is supplied with a series of zoölogical charts prepared to order, also a set of Leuckart's charts, disarticulated skeletons and other apparatus for illustrating the lectures in the class-room.

Zoölogical Museum. — This is in immediate connection with the lecture room, and contains the Massachusetts State collection, which comprises a large number of mounted mammals and birds, together with a series of birds' nests and eggs, a collection of alcoholic specimens of fishes, reptiles and amphibians, and a collection of shells and other invertebrates.

There is also on exhibition in the museum a collection of skeletons of our domestic and other animals, and mounted specimens purchased from Prof. H. A. Ward; a series of glass models of jelly fishes, worms, etc., made by Leopold Blaschka in Dresden; a valuable collection of corals and sponges from Nassau, N. P., collected and presented by Prof. H. T. Fernald; a fine collection of corals, presented by the Museum of Comparative Zoölogy in Cambridge; a collection of alcoholic specimens of invertebrates from the coast of New England, presented by the National Museum at Washington; a large and rapidly growing collection of insects of all orders; and a large series of clastique models of various animals, manufactured in the Auzoux laboratory in Paris.

It is the purpose of those in charge to render the museum as valuable to the student as possible; and with this end in view the entire collection has been rearranged so as to present a systematic view of the entire animal kingdom, with especial regard to the fauna of Massachusetts. In the furtherance of this idea a special case has been prepared, in which are shown typical animals in such a way as to give a brief synopsis of the entire animal kingdom, forming a sort of index to the museum as a whole. In order to render our collection complete, especially in regard to Massachusetts forms, we would gratefully receive donations of any sort, either alcoholic or otherwise preserved, especially among the worms, fishes, amphibians or reptiles. Specimens should be sent care of Prof. R. S. Lull. The museum is now open to the public from three to four P.M. every day except Sunday.

Zoölogical Laboratory. — A large room in the laboratory building has been fitted up for a zoölogical laboratory, with tables, sink, gas, etc., and is supplied with a reference library, microscopes, chemical and other necessary apparatus for work. This

laboratory with its equipment is undoubtedly the most valuable appliance for instruction in the department of zoölogy.

Veterinary Department.

This department is well equipped with the apparatus necessary to illustrate the subject in the class-room.

It consists of an improved Auzoux model of the horse, imported from Paris, constructed so as to separate and show in detail the shape, size, structure and relations of the different parts of the body; two *papier-maché* models of the hind legs of the horse, showing diseases of the soft tissues, — wind-galls, bogs, spavins, etc., also the diseases of the bone tissues, — splint, spavins and ring-bones; two models of the foot, one according to Bracy Clark's description, the other showing the Charlier method of shoeing and the general anatomy of the foot; a full-sized model of the bones of the hind leg, giving shape, size and position of each individual bone; thirty-one full-sized models of the jaws and teeth of the horse and fourteen of the ox, showing the changes which take place in these organs as the animals advance in age.

There is an articulated skeleton of the famous stallion, Black-hawk, a disarticulated one of a thorough-bred mare, besides one each of the cow, sheep, pig and dog; two prepared dissections of the fore and hind legs of the horse, showing the position and relation of the soft tissues to the bones; a *papier-maché* model of the uterus of the mare and of the pig; a gravid uterus of the cow; a wax model of the uterus, placenta and fœtus of the sheep, showing the position of the fœtus and the attachment of the placenta to the walls of the uterus.

In addition to the above there is a growing collection of pathological specimens of both the soft and osseous tissues, and many parasites common to the domestic animals. A collection of charts and diagrams especially prepared for the college is used in connection with the lectures upon the subject of anatomy, parturition and conformation of animals.

Through the kindness of Mr. Henry Adams of Amherst the department has received a large sample collection of the various drugs used in the treatment of the diseases of the domestic animals.

For the benefit of the students, sick or diseased animals are frequently shown them, and operations performed in connection with the class-room work. For the use of the instructor of this department a laboratory has been provided in the old chapel building. It has been equipped with the apparatus necessary for

the study of histology, pathology and bacteriology, consisting in part of an improved Zeiss microscope with a one-eighteenth inch objective, together with the lower powers; a Lautenschlager's incubator and hot-air sterilizer; an Arnold's steam sterilizer and a Bausch and Lomb improved laboratory microtome. This apparatus is used for the preparation of material for the class-room and for general investigation.

Mathematical Department.

The instruction embraces pure mathematics, civil engineering, mechanics and physics. For civil engineering there are an Eckhold's omnimeter, solar transit, three engineer's transits, surveyor's transit, gradienter, plane table, two common compasses, two levels, one architect's compass level, six surveyor's chains, six levelling rods of various patterns, cross-section rod and such other incidental apparatus as is necessary for practical field and railroad work.

For mechanics there is a full set of mechanical powers and a good collection of apparatus for illustration in hydrostatics, hydrodynamics and pneumatics. There is also a supply of physical apparatus for illustrating the general principles of sound, heat and light.

For practical study in electricity there are several electrical machines, small hand dynamo with complete outfit of necessary apparatus, coils, standard one thousand ohm resistance box, Wheatstone's bridge, testing set, sine and tangent galvanometer, Thomson's reflecting galvanometer with shunt box and standard scale, electrometer, direct reading voltmeter and ammeter, and a large quantity of less expensive but important apparatus for class-room illustration and laboratory work. Much of this collection is new, having been recently added, and thus the facilities for practical information in this department have been greatly increased.

The lecture room is large, and adjacent to it is a workroom and the physical cabinet.

Chemical Department.

Instruction in general, agricultural and analytical chemistry and mineralogy is given in the laboratory building. Thirteen commodious rooms, well lighted and ventilated and fitted at large expense, are occupied by the chemical department.

The lecture room, on the second floor, has ample seating capacity for seventy students. Immediately adjoining it are four smaller rooms which serve for storing apparatus and preparing material for the lecture table.

The laboratory for beginners is a capacious room on the first floor. It is furnished with forty working tables. Each table is provided with sets of wet and dry reagents, a fume chamber, water, gas, drawer and locker, and apparatus sufficient to render the student independent of carelessness or accident on the part of others working near by; thus equipped, each worker has the opportunity, under the direction of an instructor, of repeating the processes which he has previously studied at the lecture table, and of carrying out at will any tests which his own observation may suggest.

A systematic study of the properties of elementary matter is here taken up, then the study of the simpler combinations of the elements and their artificial preparation; then follows qualitative analysis of salts, minerals, soils, fertilizers, animal and vegetable products.

The laboratory for advanced students has just been fitted up in the room, also on the first floor, previously known as the chapel. Here tables for thirty workers, besides large fume chambers and distillation tables with ample supplies of gas and water and all kinds of apparatus, have been arranged. This is for instruction in the chemistry of various manufacturing industries, especially those of agricultural interest, as the production of sugar, starch fibres and dairy products; the preparation of plant and animal foods, their digestion, assimilation and economic use; the official analysis of fertilizers, fodders and foods; the analysis of soils and waters, of milk, urine and other animal and vegetable products.

The balance room has four balances and improved apparatus for determining densities of solids, liquids and gases.

Apparatus and Collections. — Large purchases of apparatus have recently been made. Deficiencies caused by the wear and breakage of several years have been supplied and the original outfit increased. The various rooms are furnished with an extensive collection of industrial charts, including Lenoir & Foster's series and those of Drs. Julius and George Schroeder. The apparatus includes balances, a microscope, spectroscope, polariscope, photometer, barometer and numerous models and sets of apparatus. A valuable and growing collection of specimens and samples, fitted to illustrate different subjects taught, is also provided. This includes rocks, minerals, soils, raw and manufactured fertilizers, foods, including milling products, fibres and other vegetable and animal products and artificial preparations of mineral and organic compounds. Series of preparations are used for illustrating the various stages of various manufactures from raw materials to finished products.

Military Department.

United States Property.

Ordnance.

2 light twelve-pound brass guns with implements.
2 3.2-inch breech-loading steel guns with implements.
2 eight-inch mortars with implements.
4 gun carriages.
2 gun caissons.
2 mortar beds.
2 mortar platforms.
147 Springfield cadet rifles.
147 infantry accoutrements, sets.
51 headless shell extractors.
100 blank cartridges for field guns.
5,000 metallic ball cartridges
1,000 metallic blank cartridges.
300 friction primers.
4,000 pasters.
100 targets, A and B.
30,000 cartridge primers.
25,000 round balls.
1 set hand reloading tools.
100 pounds small arms powder.

Signal Property.

2 heliographs, complete.
6 two-foot white flags.
6 two-foot red flags.
6 canvas cases and straps.
12 joints of staffs.

Library.

This now numbers 15,800 volumes, having been increased during the year, by gift and purchase, 1,565 volumes. It is placed in the lower hall of the chapel-library building, and is made available to the general student for reference or investigation. It is especially valuable as a library of reference, and no pains will be spared to make it complete in the departments of agriculture, horticulture and botany and the natural sciences. It is open a portion of each day for consultation, and an hour every evening for the drawing of books.

PRIZES.

Burnham Rhetorical Prizes.

These prizes are awarded for excellence in declamation, and are open to competition, under certain restrictions, to members of the sophomore and freshman classes.

Military Prize.

Mr. I. C. Greene, a graduate of the class of 1894, offers a gold medal to the cadet best drilled in the Manual of Arms.

Flint Prizes.

Mr. Charles L. Flint of the class of 1881 has established two prizes, one of thirty dollars and another of twenty dollars, to be awarded, at an appointed time during commencement week, to the two members of the junior class who may produce the best orations. Excellence in both composition and delivery is considered in making the award.

Grinnell Agricultural Prizes.

Hon. William Claflin of Boston has given the sum of one thousand dollars for the endowment of a first and second prize, to be called the Grinnell Agricultural prizes, in honor of George B. Grinnell, Esq., of New York. These two prizes are to be paid in cash to those two members of the graduating class who may pass the best written and oral examination in theoretical and practical agriculture.

Hills Botanical Prizes.

For the best herbarium collected by a member of the class of 1895 fifteen dollars is offered, and for the second best a prize of ten dollars; also a prize of five dollars for the best collection of woods and a prize of five dollars for the best collection of dried plants from the college farm.

The prizes in 1894 were awarded as follows: —

Burnham Rhetorical Prizes: Patrick A. Leamy (1896), first; Salome Sastré de Verand (1896), second; Lafayette F. Clark (1897), first; Charles I. Goessmann (1897), second.

Flint Oratorical Prizes: Thomas P. Foley (1895), first; Daniel C. Potter (1895), second.

Grinnell Agricultural Prizes: John E. Gifford (1894), first; George H. Merwin (1894), second.

Hills Botanical Prizes: Louis M. Barker (1894), first; Henry J. Fowler (1894), second.

Military Prize: George H. Merwin (1894).

RELIGIOUS SERVICES.

Students are required to attend prayers every week-day at 8 A.M. and public worship in the chapel every Sunday at 10.30 A.M. Further opportunities for moral and religious culture are afforded by a Bible class taught by one of the professors during the hour preceding the Sunday morning service and by religious meetings held on Sunday afternoon and during the week, under the auspices of the College Young Men's Christian Association.

LOCATION.

Amherst is on the New London Northern Railroad, connecting at Palmer with the Boston & Albany Railroad, and at Miller's Falls with the Fitchburg Railroad. It is also on the Central Massachusetts Railroad, connecting at Northampton with the Connecticut River Railroad and with the New Haven & Northampton Railroad.

The college buildings are on a healthful site, commanding one of the finest views in New England. The large farm of three hundred and eighty-three acres, with its varied surface and native forests, gives the student the freedom and quiet of a country home.

APPENDIX.

A NEW GREENHOUSE PEST.*

ORTHEZIA INSIGNIS — Douglas.

Of the numerous insect enemies with which the horticulturist has to contend, the most troublesome by far are those belonging to the family Coccidæ. Small in size, immensely prolific and difficult to destroy, they become an abomination and a scourge, sooner or later, in every orchard, garden and greenhouse where vigorous measures are not taken to oppose them. Scale insects, bark lice and mealy bugs are the most familiar pests contained in the family, and to these may now be added *Orthezia insignis.* This little insect, which has as yet received no generally accepted common name, is an unwelcome addition to our already too long list of insects injurious in the greenhouse and flower garden. Many florists confuse it with the common mealy bug, and most of those that do distinguish it from that insect know it only by names which are not only ill-adapted but misleading.

Its Names, and What it is.

The most common of the names in use by Massachusetts florists is the "white fly," which is a decidedly inappropriate name, as the insect in no way resembles a fly. The "black-marked mealy bug" is more descriptive of it, and the "white-tailed mealy bug," by which name several designate it, recalls the insect still better.

Orthezia insignis has its mouth parts formed for piercing and sucking, and obtains its nourishment by imbibition of plant sap, like all the other species of the family to which it belongs. The young are very small, and would hardly be discerned on a plant were it not for the presence of snow-white plates of waxy matter which occur on the back and sides, and which contrast strongly with the darker background of the body. The adult females are about the size of the head of a pin and resemble the young in appearance, but bear in addition to the white plates on the back and sides a somewhat cylindrical sac of the same substance,

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* The studies on Orthezia represented in this paper were made under my direction by Mr. C. P. Lounsbury during his senior year in the Massachusetts Agricultural College. C. H. FERNALD.

AMHERST, MASS., Dec. 7, 1894.

which projects for some distance behind the insect and in which the eggs are carried. At the posterior end of this sac is an opening through which the young crawl soon after emerging from the egg. The young are then quite lively, and scatter over the stem and under side of the leaves of the plant. In this respect they differ from the mealy bugs, which are more frequently found in masses at the nodes of the stem, nestled closely to the veins of the leaves or else partly hidden in crevices of the bark. As they grow older they become sluggish; but they always retain their power of locomotion, and even the heavily egg-laden female may often be seen moving slowly along with her marsupium or ovi-sac highly elevated. The mature males have a single pair of wings, and, being very minute and also rare, are seldom noticed.

History and Distribution.

Orthezia insignis occurs native in tropical America, and also, inferring from what Mr. J. W. Douglas says concerning it, in China. The original description of it was made by Mr. Douglas from specimens found in a greenhouse in England, and was published in the "Entomologist's Monthly Magazine," volume XXIV, page 169, in 1887. The first written mention that I find of its occurrence in America is by Mr. S. D. McIntire, who in "Timehri" for December, 1889, records its presence in British Guiana. Since that time it has been found in Mexico at several places and on the Islands of Trinidad and Jamaica, and has been observed in greenhouses in several parts of the United States. In Massachusetts it was found in the greenhouses connected with the Agricultural College at Amherst in 1892, and inquiries among the florists in the central and eastern parts of the State have revealed the fact that it has been known in those places for several years. One prominent florist in Cambridge asserts that it has infested his grounds for nearly twenty years; but this is scarcely probable, as it has not yet spread to all the surrounding greenhouses. In the report of the department of agriculture for 1880, however, is a note on an allied insect occurring in Cambridge greenhouses which may possibly refer to *O. insignis*. On page 124, volume 3 of "Insect Life" is a letter dated June 23, 1890, from Charles Fremd, Rye, N. Y., in which he complains of a new insect on coleus. The reply to the letter states that the insect is an undetermined species of *Orthezia*, and that it had before been received both from New York and California. Mr. Fremd has since sent me specimens, and they prove to be *insignis*. In recent correspondence Mr. Fremd writes that the pest has now become very common among all the florists in his vicinity. It has also been

found at Ithaca, N. Y., and has been received by Massachusetts florists on plants coming from Pennsylvania. This very general distribution would seem to indicate that the insect has become firmly established in the eastern States, and may, where not already found, be expected to put in an appearance at almost any time.

Food Plants.

Orthezia insignis has a single redeeming feature over its relative, the mealy bug, in that it infests fewer species of plants. Nevertheless, it attacks many more kinds than most florists suppose. At the insectary, where it has been reared in large numbers for the purposes of observation and experiment, it has been raised upon Lantana, Aloysia and Verbena of the order Verbenaceæ, Coleus and Salvia of the Labiatæ, Libonia and Peristrophe of the Acanthaceæ, Ipomœa of the Convolvulaceæ, and Ageratum, Cineraria, Eupatorium and Stevia of the Compositæ, upon all of which it thrived well and increased rapidly. From these plants it spread to Chrysanthemum of the Compositæ, Pilea of the Urticaceæ, Cuphea of the Lythraceæ, Oxalis and Pelargonium of the Geraniaceæ, Abutilon and Malvaviscus of the Malvaceæ, Fuchsia of the Onagraceæ, Heliotropium of the Boraginaceæ and Vinca of the Apocynaceæ ; but on these plants up to the present time it occurs only in limited numbers and has not proved particularly injurious. At floral establishments visited it has been found upon most of the above plants and in addition upon Celosia and Alternanthera of the Amaranthaceæ, and Petunia of the Solanaceæ. In England Mr. Douglas mentions that plants of the order Acanthaceæ, and coleus of the Labiatæ are attacked by it ; and in Jamaica Mr. Cockerell has observed it upon potato, verbena, mint, chrysanthemum, myosotis and white violet.

The large number of natural orders represented renders it probable that even this long list of food plants is far from complete ; but it will be at once noticed that nearly all of the number are herbaceous plants and that none of them are monocotyledons. As far as I am aware citrus plants and ferns, upon which mealy bugs are often so extremely troublesome, are exempt from the attacks of this insect.

Injuries.

Coleus appears to be the most favorable plant for its increase, and it is of its injuries to this plant, especially to the variety known as *verschaffeltii*, that florists most frequently complain. During the winter it is very destructive to the coleus cuttings in the greenhouses, and if at all numerous on the young plants when

they are set out in the spring it is almost sure to increase in a short time to such prodigious numbers that it kills or greatly weakens the plants before frost in the fall. They were so plentiful at some places which came under my notice this fall that the gardeners could not find enough uninfested tips to furnish cuttings for the continuance of the stock. The stem and under side of the leaves of every plant were white with the insects and molted skins, while many of the plants had drooped and died.

Allowed to increase for a few months without molestation, in order to secure large numbers for experimental purposes, in the insectary greenhouse, it destroyed specimens of nearly all the plants mentioned above as those upon which it thrived well. It is unlikely that any florist would neglect his stock long enough to allow it to become as badly infested as were these plants; but, as the insects spread from a single plant the case serves to show how rapidly they will multiply under favorable conditions.

Remedies.

It is a difficult matter to destroy *Orthezia* with insecticides, and on this account simple preventive measures are of more importance to hold the insect in check than remedial ones. The nature of the plants which it infests renders this especially true. Most of them as already pointed out are herbaceous bedding plants, and as such plants are nearly all placed out of doors during the summer, not many insects would get into the houses to breed and cause trouble in the winter if the plants brought in from outside and the few which may have been kept in the houses during the summer were thoroughly cleaned in the fall. Cuttings for stock should only be made from uninfested plants, and cuttings or plants received from other dealers should be examined at once and rejected or cleaned if found infested; this last point is an important one, as the insect has undoubtedly been introduced into new districts through the agency of auction houses, and has often become extremely abundant before being recognized as a new enemy. Some may think that the labor involved in being particular to have only perfectly clean cuttings is not profitable; but to discover and destroy a few insects on cuttings is surely far easier and less costly than to control the many thousands which the few if allowed to remain would soon propagate.

These precautionary measures should be supplemented by frequent syringing with as severe a spray of water as the plants will stand if any insects make their appearance. Young, tender cuttings, like those of coleus, however, will not stand a syringing severe enough to wash off all the insects, and in this case as well as in certain others, resort to an insecticide is often desirable.

Fir-tree Oil. — Of the florists who use an insecticide against the *Orthezia* nearly all use fir-tree oil, and all who do, speak very highly of its effectiveness. This substance has been tried at the insectary, and when used in the proportions recommended by its manufacturers for mealy bugs, one part to ten of water, it has been found very efficient in destroying the *Orthezia*. It is, however, quite costly and possesses little merit over well-made kerosene emulsion.

Kerosene Emulsion. — This substance has of late years been proved to be a very valuable insecticide against just such insects as the present one, and yet the number of florists who use it is very small. Doubtless this is because it is a little troublesome to prepare, but those who are willing to take this trouble are well repaid. It must not be expected that every insect will be destroyed by one application of either fir-tree oil or kerosene emulsion, and, besides, the eggs in the ovi-sac are not always reached. When applied directly to the infested portions of the plant with a brush, kerosene emulsion answers as well as fir-tree oil; but for dipping the plants, and spraying, slightly better results appear to be obtained in experiment by the latter substance. Emulsion prepared according to Cook's formula has given better results on *Orthezia* at the insectary than that prepared by the ordinary or Riley-Hubbard method, and it is to the first or Cook's emulsion that reference is made in comparison with fir-tree oil. It is made by adding one pint of kerosene to a boiling solution of one-quarter pound of hard soap in two quarts of water, and churning the mixture thus formed until it is thoroughly emulsified, which takes about five minutes; for use, the emulsion is diluted with twice its bulk of water.

Alcohol. — Commercial alcohol has been recommended for touching mealy bugs to destroy them, but when tried on *Orthezia* a great many survived the treatment, and when infested plants were dipped in it few of the insects were destroyed.

Other Insecticides. — Experiments with tobacco smoke, pyrethrum, pyrethrum fumes and water at 125° F. have all been tried at the insectary, and have proved that these substances are of no value in destroying this insect. A solution of one pound of soap in ten gallons of water appeared about as effective as the kerosene emulsion, but was less agreeable to use. Pure kerosene sprayed on with a Woodason's spraying bellows killed every insect with which it came in contact; but the number of plants upon which kerosene can be used without injury is small.

The insects remaining on the plants left out of doors are killed by the first severe frost, so no danger need be apprehended from them.

Technical Description of the Insect.

Male (Plate 1). — Body slender, dusky in color, 1.1 mm. in length. Head (Figure 7) smaller than the thorax. Eyes large and prominent. Ocelli two, situated in front of and between the basal joints of the antennæ where the mouth parts would be expected to be; another pair of organs, apparently also ocelli, occur outside of and in advance of the eyes. Antennæ (Figure 2) long, yellowish-brown, slightly moniliform, ten-jointed; first joint stout, as broad as long; second much broader than those following, ovate with the basal end the smaller; third longest of all, long ovate; the remaining joints oval, all but the tenth subequal in length, the tenth longer than any but the third. All the joints clothed with long hairs. Thorax large, raised and rounded in front; "the disc with a large, wide and deep depression; scutellum with a large median hollow." (Doug.) Legs (Figure 5) pale brown, with long, scattering dark hairs. Coxa stout, separated from the femur by two distinct joints; the first somewhat quadrate, the second triangular; tibia a trifle longer than femur; tarsus one-third the length of the tibia, tipped with a long claw or stout spine. Wings two, ovate, transparent, expanding 2 3-5 mm.; veins two, not very distinct, united at the base; extending forward from the principal vein between the base of the wing and the place of furcation are three fine, short spines. Halteres (Figure 4) slightly fusiform, each with a long bristle terminating in a single hook which fits into a pocket (Figure 3) in the base of the wing. Abdomen slender, about as long as the head and the thorax together, and bearing a few short hairs on each segment; margins of the segments bluntly dentate. Genitalia (Figures 6 and 8) prominent, projecting from the ventral side of the last segment. From each side of the same segment projects a snow-white filament as long and oftentimes even longer than the body of the insect; the white matter is easily broken away, disclosing each filament to be composed of two long and one short setæ.

The males of *Orthezia insignis* are few in number in comparison with the females. For several months I kept an infested plant under a glass jar, and, although the jar and the plant were examined at least twice a day, I did not succeed in obtaining over a dozen or fifteen specimens of the adult. Of the earlier stages I know nothing. The description given was made from specimens mounted in glycerine.

Adult Female (Plate 2). — Body broadly oval, 1.2 mm. wide by 1.5 mm. in length, exclusive of lamellæ; varying in color on the dorsal surface from ochreous mottled with very dark dull green

between the segments to an almost uniform dark dull green. Ventral surface usually darker and more uniform. Segmentation quite distinct, especially toward the posterior end. Rostrum (Figure 5) seldom visible from above, provided with a long, retractile piercing organ, composed of three (in reality four, the middle one being double) grooved bristles which are frequently seen separated. Antennæ (Figure 3) as long as the coxa, femur and tibia of the fore leg, inserted between and slightly in advance of the simple, projecting, prominent eyes; eight-jointed, all fulvous except the last, which is black; the first joint very stout; the second shortest of all and much stouter than those following; the third the longest with the exception of the last; the fourth, fifth, sixth and seventh about equal in length; eighth long, slightly fusiform and tipped with a short, blunt spine; finer spines occur scatteringly all along the antennæ. Legs (Figure 4) light yellowish-brown with darker tarsi, armed with numerous fine spines; coxa stout; femur and tibia of about equal length; tarsus three-fifths the length of the tibia, with a single terminal claw; fore legs a trifle shorter than the others.

The surface of the body is partially concealed by plates or lamellæ of a wax-like substance, arranged as follows: from each segment, beginning with the second thoracic, a large lamella arises from the dorsum near the lateral margin; the first of these lamellæ is somewhat triangular in outline and projects slightly forward; the second and the third are shorter and broader than the first and project outwardly; those from the fourth on are narrower and longer and are curved downwards and backwards over the marsupium; between the two ninths in the median line immediately behind the anus is a short and broad lamella deeply grooved at the basal end, generally lying in a horizontal position but often inclined to the vertical. On each side of the median line from the base of the antennæ to the posterior end of the body is a row of narrow, small lamellæ; the first two of each row approaches its mate at its posterior extremity; the two rows then separate more widely but soon again approach each other, thus enclosing a somewhat oval area on the middle of the dorsum; behind this oval area the two rows are almost contiguous, and the lamellæ composing them are small and extend outwardly on the anterior portion, but are more elongated and curved to the rear as they approach and surround the anal opening. Between the antennæ a small lamella extends out over the head and is continued around on the ventral surface, where it broadens out under the bases of the antennæ. On the ventral surface series of lamellæ corresponding and contiguous to the lateral series of the dorsal surface occur; the first

and third lamellæ are similar in form to the corresponding dorsal ones, the second is entirely absent, the fourth is more elongate than its mate, while those beyond are closely united, extremely elongated and form the upper surface of the marsupium. Single lamellæ occur on each side of the rostrum, and before and behind the coxa of each leg. Those behind the last legs are quite large, situated somewhat between the coxæ, and project over the marsupium. Posterior to the bases of these the broad, lamellar plate forming the under side of the marsupium has its origin. The marsupium, varying from 3 to 5 mm. in length, generally nearly straight but often much curved upwards, sides slightly convergent, end truncate; lower surface smooth, rounded; upper surface less rounded, marked with longitudinal furrows showing where the lamellæ composing it are united; middle furrow much wider than the others. At the posterior end is a rectangular aperture, variable in size, through which the young issue.

The lamellæ vary a trifle in form on different individuals. They are finely striated, compact masses of a brittle, snowy-white substance, which easily reduces to a powder. This substance possesses the same chemical properties as wax; it melts when subjected to a heat of 180° F.; is not acted upon by alcohol, but is very soluble in chloroform and to some extent in turpentine. It is secreted by numerous fine papillæ which project through the chitinous integument. These papillæ are discernible only when the lamellæ covering them have been removed or rendered translucent with potash or soda. Specimens mounted in Canada balsam soon lose all trace of the lamellæ. The fragile nature of the lamellæ often leads to their destruction, and insects are often found almost entirely nude because of this; but if these insects are watched, it will be observed that new lamellæ form in place of those which were lost.

Early Stages of the Female.

Egg. — The eggs are ovate in outline, pale brownish-yellow, and are laid in the marsupium in a mass of fine waxen threads which are of the same nature as the lamellæ. The egg-laying commences soon after the marsupium begins to project beyond the abdomen, and probably continues until those first laid begin to hatch, as the total progeny in the marsupium appears to be most numerous when some of the eggs have hatched. The number of eggs laid varies from 125 to 175; in some cases even more than the last number are laid; one marsupium from which a few young had already escaped was dissolved in chloroform, and 74 eggs and 114 young were disclosed. The eggs hatch in about two months from the date of laying.

First Stage. — The young when hatched from the egg are entirely naked, but before leaving the ovi-sac they become coated with the lamellar secretion. The lamellæ in this stage are larger in proportion to the body than in later stages, and they give the insect a somewhat wedge-shaped outline. The one projecting between the antennæ and the first of the median-dorsal and lateral series are especially large. Occasionally a specimen is found with the lamellæ at the posterior end extremely elongated; possibly this would be the case with all specimens if they suffered no mutilation. The legs are stouter proportionately than in the adult; there is no joint between the tibia and the tarsus, but a faint ring-shaped marking where the joint would be if present is visible under the microscope. The antennæ are six-jointed; the last joint is the longest, while the remaining joints are about of an equal length; the first and second are stouter than those following.

Second Stage. — The denuded body is oval, but the form of the lamellæ gives the uninjured insect a rectangular appearance. The lamellæ on the sides of the body are laterally connected, shorter in front than behind; the last few project beyond the body and appear as one. Those composing the median-dorsal series are prominent and appear in two distinct rows anteriorly, but are small, confused and in one row behind. The antennæ are six-jointed and tapering; the last joint is the longest, the first the shortest, and the second, fourth and fifth subequal in length. A division between the tibia and tarsus is evident, but the two parts apparently move as one.

Third Stage (Figure 6, Plate 2). — The insect has much the same appearance as before molting. The lamellæ behind are less united than before, and those of the front part of the median series are less prominent. The antennæ are seven-jointed; the first and second joints are short, the third to the seventh are subequal, and, as before, the eighth is the longest. The dividing line between the tibia and the tarsus is distinct and the leg is slightly bent at this point.

Fourth Stage. — The insect now varies from the fully matured form only in the development of the lamellæ. These are not laterally connected, and the one between the antennæ shows a median sulcation. The marsupium at once begins to form, but does not become apparent from above until the second week after molting.

The molts do not occur at definite intervals, nor do insects which emerge together from the marsupium molt at the same time. With each molt the entire lamellar coat is thrown off, and new lamellæ at once begin to form. In general, the interval between

the molts is from two to three weeks. The adult lives about four months; the entire life of the insect is approximately six months, and the time necessary for a generation is about fourteen weeks.

As noted above, the early stages of the male have not been studied. I am quite certain that those from which the descriptions of the different stages were made were all females, as in each case specimens answering the same description were saved, and proved females.

Writers on other species have described the male nymphs as differing from the female nymphs, and so such is probably the case with *insignis*. I have a single specimen of *O. annæ*, differing in form from any other, which bears what may be rudimentary caudal setæ at the posterior end. The antennæ of this specimen are but six-jointed, while its body is much larger than other specimens with seven-jointed antennæ.

The descriptions above given were all made from specimens newly mounted in glycerine.

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For some of these references I am indebted to the kindness of Mr. T. D. A. Cockerell.

Other Species of the Genus.

Although up to the present time *insignis* is the only species of the genus *Orthezia* which has been reported to make itself obnoxious as a pest either in or out of doors, it is possible and quite probable that other species may become or already are injurious, and remain as yet undetermined or confused with described species. To aid those who take an interest in the matter in identifying as far as possible these pests if they do occur, descriptions of all the known species have been compiled from the most reliable sources, and are here given.

The generic name of *Orthesia* was given by Bosc, a French naturalist, in 1784, in honor of the Abbé d'Orthez. Soon afterwards the abbot became known as Dorthes, and in consequence the name of the genus was changed from *Orthesia* to

Dorthesia. The alteration was accepted at the time by many prominent entomologists; but as such a change is not permissible according to the rules governing zoölogical nomenclature, the original name was restored by Amyot and Serville in their work on the Hemiptera in 1843. They, however, changed the spelling of the word from *Orthesia* to *Orthezia*, in order to have it better conform with its derivation, and subsequent writers have usually adopted this new orthography.

The only full generic characters which have been published were given by Signoret, and were drawn from a single species; therefore they are naturally too restricted to include all the species which other authors have thought proper to place in the genus. The characters here given as generic are deduced from the descriptions of the different species. Those of the female are sufficiently complete to distinguish the genus, but those of the male will answer, with the possible exception of one or two details, for closely allied genera; they are, however, as full as can be obtained without a thorough comparative study of all the species. The characters given by Ashmead for the genus in his table for separating the genera of the Coccidæ (Trans. Amer. Ent. Soc., XVIII, p. 98, 1891) are not applicable to all the species.

Generic Characters.

Adult Male. — Head, thorax and abdomen distinct. Eyes and ocelli present. Antennæ long, filiform, nine or ten jointed. Wings two, diaphanous, with one furcate nerve. Halteres, each with a bristle which hooks into a pocket in the base of the wing. Legs long, pubescent, with one claw; no digitules. Two or more long, slender, snow-white filaments project from near the posterior end.

Adult Female. — Head, thorax and abdomen not separated. Antennæ eight-jointed; in *mœnariensis* nine-jointed (Doug.). Tarsus with one claw without digitules. Eyes simple. Anal ring with six setæ. Body more or less covered with cereous matter arranged in compact symmetrical plates. The eggs are laid in an elongated ovi-sac which projects behind the body, and are there carried until they hatch. The insect is active throughout its entire life.

Table of Species.

This table is based upon characters ascribed to the adult female in published descriptions. The adult male of so few species is known that a synoptical table based on its characters would be too imperfect to be of any value. Two species, *edwardsii* and *ameri-*

cana, are omitted, the former because the female form is unknown, and the latter as no distinguishing characters are given in its description.

1. Antennæ with eight joints, ... 2.
   Antennæ with nine joints, ... mænariensis.
2. Dorsal surface nearly naked, ... insignis.
   Dorsal surface almost or wholly covered by lamellæ, . . 3.
3. Thoracic segments each with a median wedge-shaped lamella, 4.
   Thoracic segments without median wedge-shaped lamellæ, . 5.
4. Wedge-shaped lamellæ small, not overlapping each other, . cataphracta.
   Wedge-shaped lamellæ large, overlapping each other, occidentalis.
5. Posterior lamellæ adherent to marsupium, . . . floccosa.
   Posterior lamellæ distinct from marsupium, ... 6.
6. Narrow strip of the body visible within the lateral margins, prælonga.
   Lamella between the antennæ, bilobed and much larger than those behind it, ... urticæ.
   Dorsum marked by a furrow, legs and antennæ pale brown to dark brown, tarsi black, ... annæ.

Orthezia occidentalis Douglas.

[Figures 3 and 4, Plate 3.]

"*Female Adult.* — Short-oval, piceous, covered with white cereous matter, forming above the head an obtuse gibbous projection, and thence on the margin all around, as a raised border, a series of broad, upward-curving, laterally joined lamellæ, slightly longer posteriorly, meeting there in a broader, channeled, projecting plate; marsupium (in this example) only incipient. On the uneven dorsal surface (within the lateral border), lying in a depression in the middle of each of the three thoracic segments, a scutelloid, obtusely pointed, concave, wedge-shaped plate extends backward on to the next segment, interrupting, as it were, the lamellæ which extend from side to side; their lower edge is not straight, but next to the cuneate plate on each side of it is curved up to it, and its raised surface there is hollowed out or flattened. On the other segments the lamellæ are of similar form but shorter (narrower), and are interrupted in the middle by a continuous longitudinal, angular furrow, of which the sides are raised into obtuse points on each segment. Legs, and antennæ of eight joints, piceous. Length (without marsupium), 4 mm.

"*Male Larva* (or what I deem to be such). — Like the adult female except in size, but the three thoracic cuneiform plates and the points on the edges of the abdominal furrow are all more sharply defined, and the terminal projecting lamella of the circumferential series is conical. Length, 2.5 mm."

This description is taken from an article by Mr. J. W. Douglas on page 214 of the "Entomologist's Monthly Magazine" for 1881. The specimens from which Mr. Douglas made the description were found in an ant's nest in Custer County, Colorado, by Mr. T. D. A. Cockerell. The male imago is unknown.

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Insect Life, IV, p. 158, 1891.
Trans. Amer. Ent. Soc., XX, p. 366, 1893.
Can. Ent., XXVI, p. 31, 1894.

ORTHEZIA ANNÆ Cockerell.

"*Adult Female.* — Length, $2\frac{1}{3}$ mm., with ovi-sac 8 mm. Body above covered with white secretion, which forms lateral and subdorsal longitudinal keels; dorsum marked by a furrow. Ovi-sac with eight longitudinal ridges above, none below. Legs and antennæ dark brown, antennæ varying to pale brown, legs to brown with black tarsi. Tibia about as long as femur, tarsus about half as long as tibia. Claw large, only slightly curved. Antennæ with the third joint slightly longer than the second, but somewhat constricted in the middle, so as to appear in some specimens like two joints. First joint about as long as the second. Lower lip elongated, as usual in the genus. Derm with numerous small spines similar to those of *O. insignis*, but not placed quite so closely together.

"*Larva.* — Legs sepia brown, tarsus decidedly longer than the tibia; claw long and slender, nearly straight. Antennæ 6-jointed; 6 as long as $3+4+5$, which are about equal and shortest; 3 slightly longer than 4 or 5, 2 longer than 1. Formula 6213 (45).

"*Adult Male.* — Length of wing, $1\frac{3}{4}$ mm. Body, legs and antennæ black, dorsum of the thorax pitch black. Wings pale grey or greyish white, with the costa black. Eyes strongly facetted. Legs bristly, tarsus less than one-third length of tibia. There is a brush of white caudal filaments, not covered by secretion, over ten in number; they are longer than the wings. The wings seen against a dark surface appear white and are slightly iridescent. The genitalia are more elongated than in *O. insignis* as figured by Douglas." (Cockerell.)

Found in New Mexico on Chenopodium and Atriplex canescens.

Mr. Cockerell kindly sent me live specimens of this species, but unfortunately their lamellæ became much mutilated on their long journey, and they died before I could find a food-plant acceptable

to them. I think their lamellæ are of a less compact nature than those of *O. insignis*. The nymphs bore a general resemblance to the specimens marked *O. americana* in the collection of Professor Herbert Osborn of the Iowa Agricultural College Experiment Station (see Figure 6 on Plate 3), while the adults were more of the form figured as a nymph by Comstock (see Figure 5 on Plate 3).

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Ann. and Mag. Nat. Hist., November, 1893, p. 403 (fig. of end of male abdomen).

Psyche, VI, p. 572, 1893.

Can. Ent., XXVI, pp. 32, 285, 1894.

Orthezia americana (Walker).

[Figures 5, 6 and 7, Plate 3.]

"Yellow, elliptical, enclosed in short white scales; feelers and legs reddish ferruginous. Length of the body $1\frac{1}{2}$ lines."

This description, copied from Francis Walker's "List of the Specimens of Homopterous Insects in the Collection of the British Museum," is very incomplete, but there is no other published one.

In the report of the Department of Agriculture, 1880, page 349, Professor Comstock writes: "In the collection of Professor Uhler are a number of specimens of species of *Orthezia* labelled 'Canada' and 'Grimsby, Ontario.' One specimen bears the label 'On Golden Rod.' These specimens seem, on superficial examination, to be specifically identical with a type specimen of Walker's *Orthezia americana*, which is also in Professor Uhler's collection. I have found immature specimens of what may be the same species upon the common burdock (*Arctium officinale*) at Ithaca, N. Y." A figure of one of these immature forms is given in the report, and a copy of it is given on Plate 3.

Two or three writers have understood the description of the genus given by Comstock on the same page as the above to be a description of *americana*, but this description appears to be a translation of Signoret's generic characteristics of *Orthezia* given in the "Annales de la Sociètè Entomologique de France."

In the collection at the Iowa Agricultural College are several specimens determined by Mr. Ashmead as *O. americana*. These were kindly loaned to me by Professor Osborn, and one of them is figured on Plate 3. There are eight joints in its antennæ, so it is in all likelihood an adult with the marsupium not yet developed. Evidently it differs from the form figured by Comstock as *americana* with doubt.

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Can. Ent. XXVI, p. 31, 1894.

ORTHEZIA EDWARDSII Ashmead.

"*Male Sac.* — This is broadly oval, pure white, .15 of an inch long by .12 of an inch in breadth. It was evidently formed by a secretion of fine, waxy flakes, the regularity of which has been lost as the insect reached maturity, the dorsal disk being entire, and the flakes only being partially distinguishable at the margins.

"*Male.* — Length, .12 inch; style, about .04 inch. Entirely black, excepting a reddish cast on the mesothorax, scutellum, metathorax, abdomen at sides and beneath, and the epipleura of the mesothorax; while the head beneath the insertion of the antennæ is pale yellowish white. Head small, nearly quadrate, being but slightly narrowed posteriorly. The eyes consist of five or six ocelli placed at the side of the head, while the mouth consists of two large, quite prominent ocelli. Antennæ very long, the points of which have four or five irregular nodose swellings, with irregular whorls of long, delicate bristles; the first two joints are very short, not as long as wide, the third and fifth joints the longest, about an equal length, the fourth, sixth, seventh, eighth and ninth shorter and gradually sub-equal, the tenth or apical joint more thickened, fusiform, about four-fifths the length of the penultimate joint. Thorax short, less than one-half the length of the abdomen; the prothorax is hardly distinguishable from above, being but a delicate ridge or collar; mesothorax quite short, somewhat trapezoidal in outline, and obliquely ascending towards the scutellum, but with a depression in the middle, the lateral lobes distinct; scutellum highly convex, polished, with some short hairs on the disk, abruptly transversely divided by a deep, yellowish fissure posteriorly. Metathorax very short. Legs very long, rather slender, black, with a long, fine hair pubescence; tibia longer than their femora, slender, cylindrical; tarsi less than one-third the length of tibiæ, and more slender, gradually acuminate

toward apex and terminating in a small, delicate claw ; no digitules. Abdomen, on the dorsum, wrinkled, at the sides toward apex covered with a white, waxy substance, and terminating in two very long caudal setæ, more than double the length of the insect, rather thickly covered with a white, waxy substance, especially at base, so that in reality they are much more slender than they appear. Style long, blackish. Wings two, white, of the ordinary shape, but I can detect a spurious vein, springing from near the base of the longitudinal vein, between it and the costal margin, and running parallel with it to half the length of the wings. I have examined many male coccids, but never before noticed this spurious vein, and consequently think it of great importance. Halteres linear, terminating in a hook with two teeth ; one of the halteres is attached to a fold or thickening in the front wing, and, as has before been observed, evidently greatly assists the insect in its flights ; the other one was loose, and thus enabled me to make out the two small teeth."

This description, published by Mr. W. H. Ashmead in the Canadian Entomologist, Volume XX, page 202, was made from two specimens found by the late Mr. Hy. Edwards in Napa County, California. The female has never been discovered.

Bibliography.

Can. Ent. XX, p. 202, 1888.
Ann. and Mag. Nat. Hist., November, 1893, p. 404.

ORTHEZIA PRÆLONGA Douglas.

[Figures 1 and 2, Plate 3.]

"*Female Adult.* — Long and narrow ; pitchy black, covered with snow-white cereous laminations. Antennæ long, slender, ochreous, base and apex piceous. Legs slender, ochreous. Two large, thick, laterally conjoined lamellæ project over the head ; the upper surface of the body throughout covered with thick cereous matter, formed of conglomerate lamellæ, the rounded ends of which do not quite reach the sides of the body, but terminate abruptly and leave the ground color narrowly visible within the lateral margins ; the middle of this mass is traversed lengthwise by a deep furrow ; on the outer sides of the body are narrow laminæ extending downwards, and continued in consecutively lengthening series round to the anal region, so that they project greatly and lie in the channels of the marsupium ; marsupium much shorter above than beneath ; of the raised lines between the channels the two outer have their posterior ends curved round towards each other ; the lower surface curved upwards, the end

especially more turned up suddenly, so that it is at a much greater elevation than any other part of the surface, and between it and the end of the upper side is a large open cavity; the outer sides of the marsupium finely channeled longitudinally, the under surface smooth. Antennæ of eight joints. Length of body, 2, with marsupium, 4.5; breadth, 2 mm. Male unknown." (Douglas.)

Found in Trinidad, Jamaica and British Guiana on Capsium and Sauchezia.

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Ent. Mon. Mag. 1891, p. 246 (fig.).
Insect Life, IV, p. 334, 1891.

ORTHEZIA CATAPHRACTA (Shaw).

"*Adult Female.* — The form is broad oval, the denuded body yellowish, the cereous matter cream white. In the adult female — length, 2 lines, including the marsupium — the frontal lobe is bilobed, thick and not much projecting; the laminæ of the circumference short, all of equal breadth, curved under, the posterior ones only being a little longer than the others, forming altogether a raised compact border. On the back, the segmentation is distinctly visible throughout, the cereous matter taking the form of each segment; the body in early life flat, afterwards distended; the segment next to the frontal lobe entire, the rest divided by a median impressed line, on which, in the first three of the divided segments, is a very small scutelliform nodule, and at the end of the line, immediately adjoining the laminæ of the circumference, is a somewhat elevated lamina arising at the anal orifice and projecting over them. The marsupium is short (varying in length), broad, the posterior angles rounded off, the upper surface, arising below the circumferential border, but distinctly separate from it, nearly flat, having only eight or nine slightly raised longitudinal lines; the lower surface, arising at the posterior coxæ and hiding the abdomen, convex, perfectly smooth, the end curved upwards. Antennæ and legs pale piceous. Sometimes the upper surface, more rarely the lower also, assumes a smoky hue." (Douglas.)

Antennæ eight-jointed. Tarsus three-fifths the length of the tibia; tibia and femur about equal. (List's figures.)

"*Male.* — Grey white. Wings (two, anterior) diaphanous, at the base narrow, then immediately widening on the lower side, the whole contour being a long, broad oval; close to the nearly straight anterior margin is a strong raised nerve, which ends at about the middle of the length; from this, at a little distance from the base,

furcates a slight nerve directed towards the inner margin, but not reaching it, and becoming evanescent at about the same distance from the base as the strong costal vein. The antennæ slender, filiform, about one-third shorter than the wing, the articulation obscured. Head, thorax and abdomen also obscured by a white mealy powder; from the end of the abdomen projects a divergent pencil of about twelve white hairs, which is fully as long as the whole insect. The legs are also covered with the same kind of mealy powder, and there is a trace of it on the wings. Length, exclusive of tail, $\frac{1}{2}$ line; expanse of wings, $1\frac{3}{4}$ line." (Douglas.)

This species has a wide distribution in Europe, having been found in Lapland, Greenland, Norway, Scotland, Ireland, England and among the Alps. Its occurrence in widely separated localities has led to its being described under several names.

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Dorthesia cataphracta: —

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Dorthesia chiton: —

Zett. Ins. Lap., 314, 1840.

Orthezia urticæ: —

Sign. (syn. partim) Essai sur les Cochinelles, 423, 1875.

Orthezia signoreti: —

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Other references are: —

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Turt. Syst. Nat., II, 714.

Dorthesia chiton: —

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Orthezia signoreti: —

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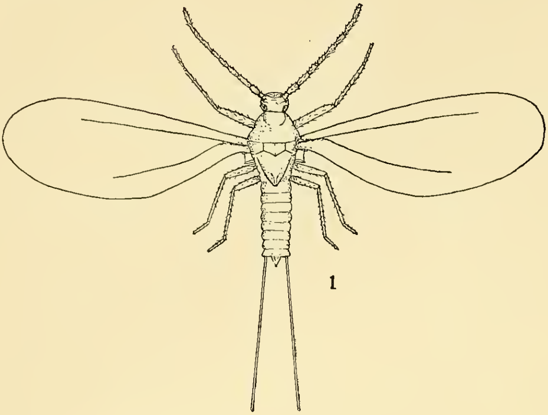
Plate 1.



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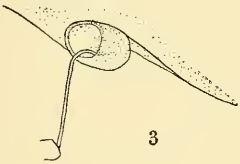

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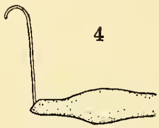

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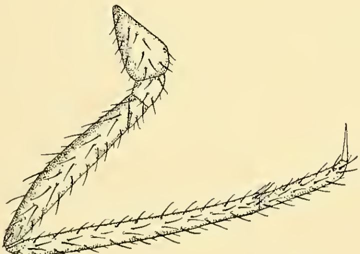

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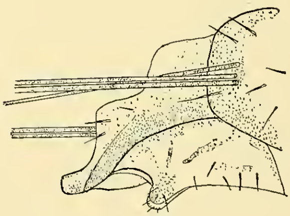

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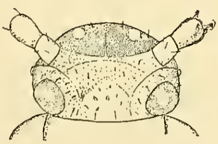

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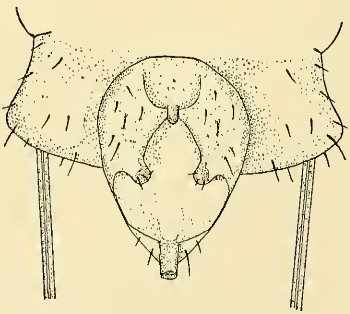

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C. P. Lounsbury.

Plate 1.

Orthezia insignis Doug., adult male.

Fig. 1. Dorsal view, enlarged 20 diameters.

2. Antenna.

3. Wing-pocket.

4. One of the halteres.

5. Hind leg.

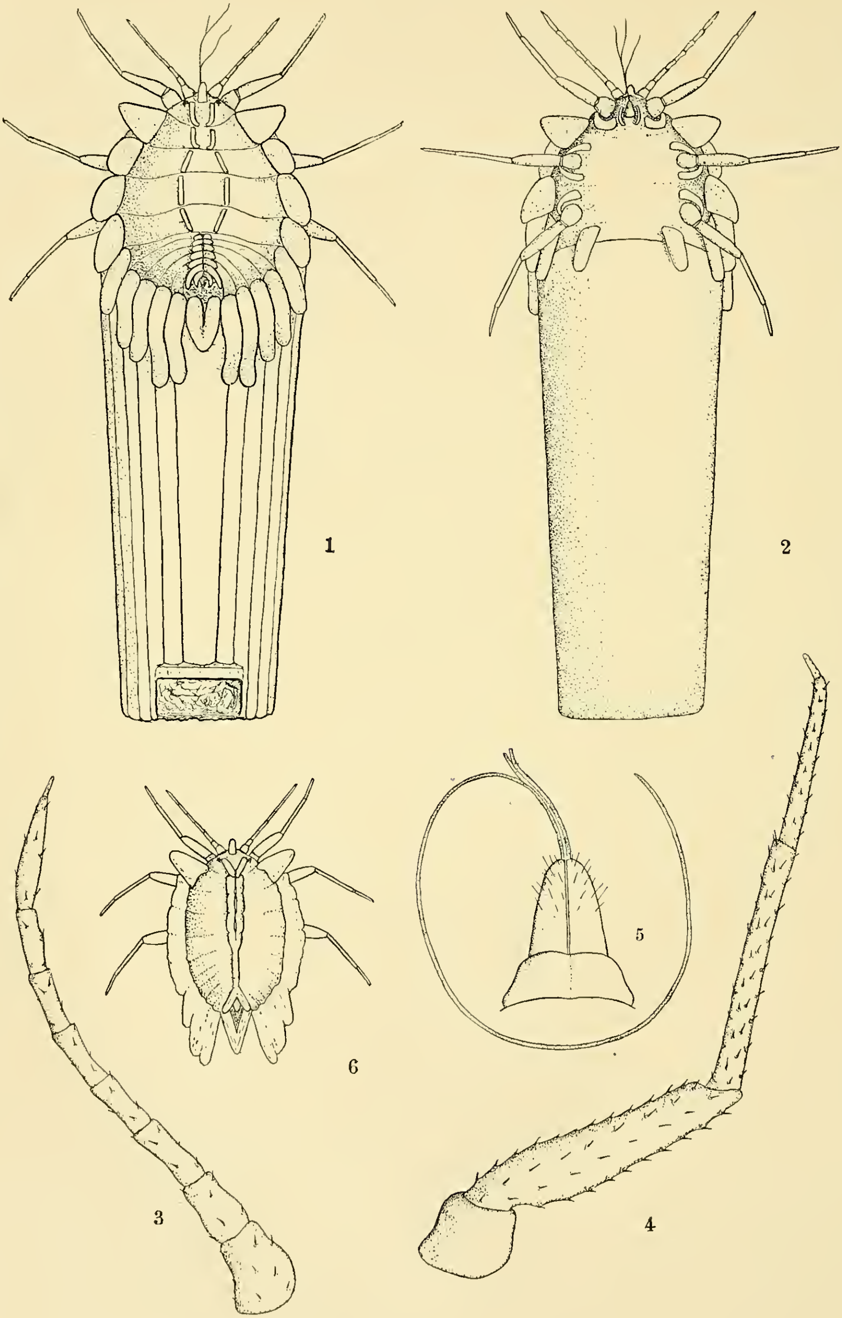
6. Lateral view of genitalia.

7. Dorsal view of head.

8. Ventral view of genitalia.

All the figures were drawn from specimens mounted in glycerine, the outlines being obtained by aid of the camera lucida.

Plate 2.



C. P. Lounsbury.

Plate 2.

Orthezia insignis Doug., female.

Fig. 1. Adult female; dorsal view, enlarged 20 diameters.

2. Adult female; ventral view, enlarged 20 diameters.

3. Adult female; antenna.

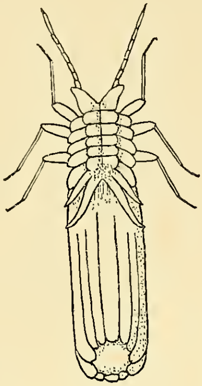
4. Adult female; fore leg.

5. Adult female; rostrum, from the front; two of the bristles are shown cut off near the base, while the third is fully extended.

6. Nymph, after the second molt.

All the figures were drawn from specimens newly mounted in glycerine; the outlines were obtained by aid of the camera lucida.

Plate 3.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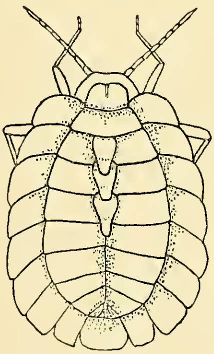
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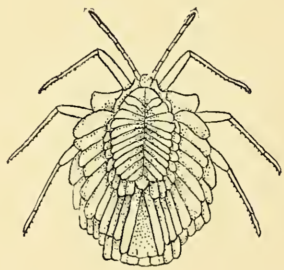
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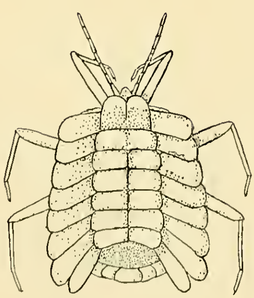
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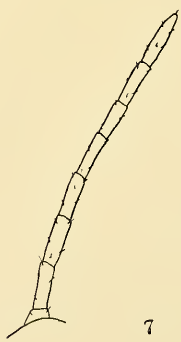
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C. P. Lounsbury.

Plate 3.

Fig. 1. Orthezia prælonga Doug., adult female.

2. Orthezia prælonga Doug., adult female; antenna.

3. Orthezia occidentalis Doug., adult female (marsupium not yet developed).

4. Orthezia occidentalis Doug., adult female; antenna.

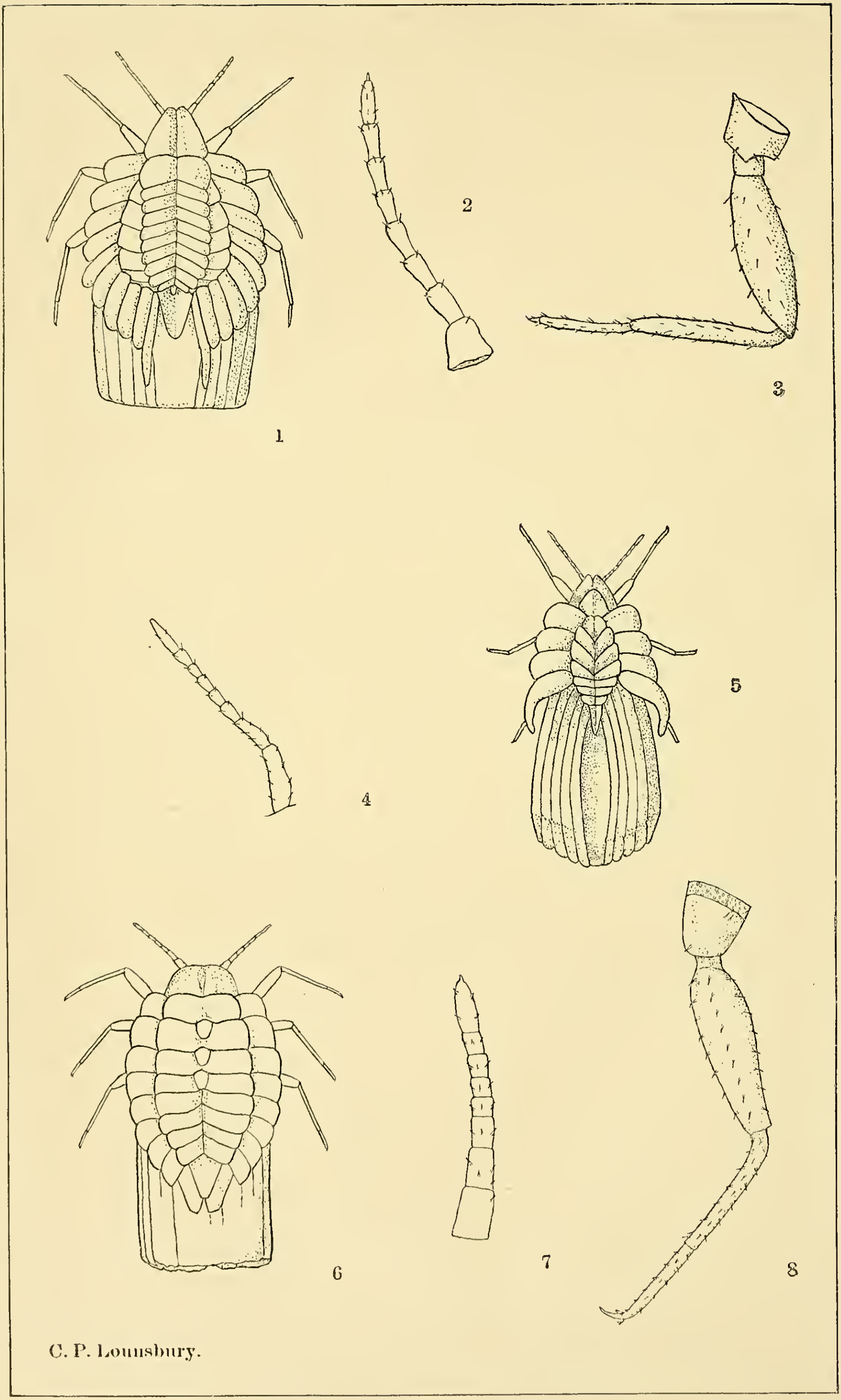
5. Orthezia americana (Walker)? nymph.

6. Orthezia americana (Walker).

7. Orthezia americana (Walker); antenna.

Figure 1 is enlarged from a figure on Plate II, Ent. Mon. Mag., 1891. Figures 2, 3 and 4 are copied from the same source. Figure 5 is copied from Plate IX, Report Department Agriculture, 1880. Figures 6 and 7 were drawn from an Orthezia labelled *americana* in the collection of Prof. Herbert Osborn; the lamellæ of the posterior part were missing from the insect.

Plate 4.



C. P. Lounsbury.

Plate 4.

Fig. 1. Orthezia urticæ (Linn.), adult female.

2. Orthezia urticæ (Linn.), adult female; antenna.

3. Orthezia urticæ (Linn.), adult female; leg.

4. Orthezia floccosa (DeGeer), antenna of adult female.

5. Orthezia floccosa (DeGeer), adult female.

6. Orthezia cataphracta (Shaw), adult female.

7. Orthezia cataphracta (Shaw), adult female; antenna.

8. Orthezia cataphracta (Shaw), adult female; leg.

Figures 1 and 5 are enlarged from figures on Plate XV, Trans. Ent. Soc., London, 1881. Figure 4 is copied from the same source. Figures 2 and 3 are copied from figures in Ann. Soc. Ent. de France, vol. 5, 1875. Figures 6, 7 and 8 are reduced from figures on Plates I and II, J. H. List's Mon. of *O. cataphracta*.

Orthezia cataphracta: —

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Orthezia urticæ (Linn.).

[Figures 1, 2 and 3, Plate 4.]

The adult female has eight joints to the antennæ; the second and eighth the longest, third, fourth and fifth about equal, the sixth and seventh sub-equal and smallest; the first thick and short, as wide as long. Legs of medium size, with the tarsus half as long as the tibia. Claw medium, with a fine hair at the base and on each side. No digitules on the tarsi. The body is elongate-oval in outline, rounded behind, narrowed in front, emarginate at the base of the antennæ, the apex rounded. Legs inserted far forward. On the last segment of the abdomen a broad anal ring with six bristles can be seen. The whole body in all the stages is covered with a lamellar, calcareous secretion, which in the adult female becomes more or less elongated, forming a sac at the end of the abdomen, which contains the eggs mingled with fine down. Later the young which are hatched remain there for some time, not coming out until they have secreted a sufficient amount of calcareous matter to shelter them. This secretion is formed by numerous hair-like "*filieres;*" these are found all over the surface of the body, and are most numerous in the perfect insect.

The male is very long, has compound eyes, and very long, filiform, nine-jointed antennæ; each joint is enlarged at the end; the first and second are very small, the third very long, the fourth to the eighth a third shorter and sub-equal, the ninth still shorter; all the joints finely pubescent. Thorax very long; wings slightly acuminate at the end. The abdomen a little enlarged in the middle, bearing on each segment a line of hairs, and upon the next to the last a fascicle of tubular hairs. Legs long, pubescent, with a very long claw. The sexual apparatus large, and occupies about a fifth of the abdomen. It consists of a pyramidal segment, very sharp at the end and removed in the middle; the thickened edges form two valves; from the middle of the upper curved part is a stylet with a straight peduncle and a crescent-shaped outer part,

the end of which is somewhat enlarged; each side is slightly pubescent.

The male is light brown in color, with long greyish-white wings; the antennæ and the legs are a little darker.

These descriptions are translated from Signoret's work; they are his generic characters, together with what he says of this particular species. Signoret calls the lamellar secretion calcareous, but in this he must be mistaken; it is certainly wax.

Mr. J. W. Douglas, the highest authority on the genus *Orthezia*, considers *Aphis urticæ*, *Orthesia characias*, *Dorthesia characias*, *Coccus dubius*, *Coccus characias* and *Dorthesia urticæ* as synonymous with *Orthezia urticæ*.

The insect feeds upon a large number of plants, principally of the orders Urticaceæ, Euphorbiaceæ and Labiatæ, and is found in many parts of Europe.

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Orthezia floccosa (DeGeer).

[Figures 4 and 5, Plate 4.]

"*Adult Female.* — Body yellowish or piceous, covered with white cereous matter; antennæ and legs yellowish, the latter sometimes piceous, with the extremity blackish; frontal node obtusely angulated, the margins usually recurved so that the middle appears sulcate; of the circumferential laminæ the first four broad, flat, rounded on the front edge, projecting; or the first three only have this character, the fourth being longer and curved outwards, the remainder narrower and straight, adhering to and not separable from the elongate canaliculation of the marsupium; of the dorsal segments that next the frontal node has an erect angulated lamina, the next three or four have each a broad, delicate, sub-erect, forwardly directed lamina, which is deeply cleft, almost divided in the middle, so that each side appears with a greatly rounded projecting edge; the other segments straight, with at most only a slight trace of lamination; at the anal orifice is a short lamina either lying flat or slightly elevated; the marsupium varies much in length, sometimes being only half that of the rest of the insect, and sometimes, but more rarely, as long as the other portion of the insect; the upper surface canaliculate, the under surface very convex, the end much recurved. Length 1½–2 lines."

This is Mr. Douglas's description of an insect which he thought to be new when he described it, and so named it *O. normani;* later, however, he considers it to be the insect described by DeGeer as *Coccus floccosus* The adult male is unknown; the female has been found in England and Germany.

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Orthezia floccosa: —

Trans. Ent. Soc. London, 1881, p. 447.

ORTHEZIA MÆNARIENSIS Douglas.

"*Male.* — Black. Head small, transverse, anteriorly narrow and incurved, posteriorly with three distinct ocelli; eyes large, anterior, prominent; antennæ pitchy black, very long; the first and second joints short, thick, sparingly setose, the remainder filiform, long, sub-equal, finely setulose. Pronotum large, subquadrate, anterior angles depressed, surface divided into four elevated convex portions. Scutellum large. Wings of the generic form very long, except at the base very broad, posteriorly rounded, transparent, smoky grey, farinose; the furcate nervure fuscous. Halteres small, sinuate, black, the obtuse apex with two recurved setæ. Abdomen short; from the upper surface of the last true abdominal segment projects a very long pencil of slender white setæ, beneath which the genital segments lie free. Legs pitchy black, setulose." In the figure, the antennæ are nine-jointed.

"*Female.* — Black; above, clothed with snow-white cereous laminations (in the specimen before me nearly all these have been rubbed off, only two or three anterior and two posterior ones remaining, the latter overlapping the base of the marsupium). Antennæ short, stout, 9-jointed, the apical joint setigerous. Marsupium snow white; above, as long as the visible portion of the body, canaliculate; beneath, arising at the posterior coxæ and entirely covering the abdomen; very convex, and posteriorly curved upwards, like the stern of a ship; smooth, finely striate. Legs black, finely setulose." (Douglas).

Found on the Island of Montecristo, Italy, on Erica arborea.

This is the only one of the described species of *Orthezia* in which there are nine joints in the antennæ of the adult female; all the other species have but eight. The abdomen of the male is relatively much shorter than in any other species, and the number and arrangement of the ocelli is also peculiar. Two setæ at the extremity of the halteres has been given as a character of no other species; but Ashmead describes the halteres of *O. edwardsii* as "terminating in a hook with two teeth."

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ECKHOLD'S OMNIMETER.

BY PROF. A. COURTENAY WASHBURNE.

This important surveying instrument, one form of which is shown in Fig. 1, measures distances and altitudes with an extraordinary degree of accuracy and great economy of time and labor; it accomplishes the work of theodolite, level and chain, and is a perfect transit theodolite.

This instrument (Fig. 1) has a powerful microscope *ab*, permanently fixed at right angles to a telescope *cd*. This microscope *ab* is now constructed with a long diagonal eye-piece fitted parallel to the telescope *cd*, thus bringing the eye-pieces of the microscope and telescope close to each other, and rendering the operation of reading the scale *AB* easier. Both telescope and microscope move on the same axis *O*, hence the axis of *cd* is always perpendicular to the axis of *ab*.

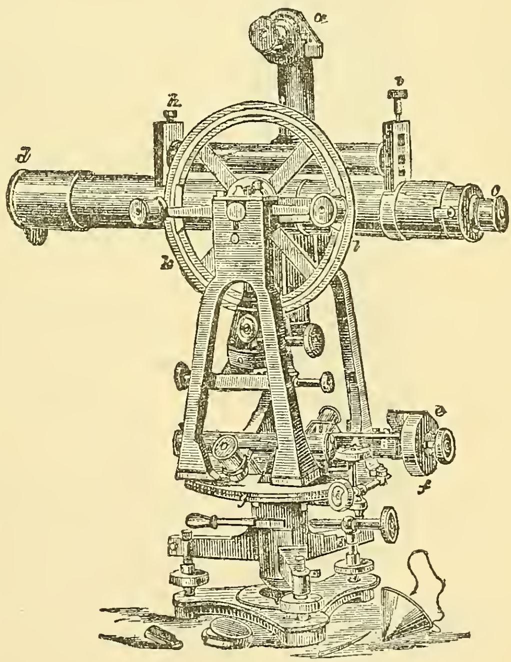

FIG. 1.

The microscope is directed to the divisions of a finely divided scale *AB* which is fixed to the horizontal plate *g*. This scale is four inches in length, divided into 64 numbered equal parts; each of these 64 parts is halved by an unnumbered line; thus the four-inch scale *AB* is divided into 128 equal parts.

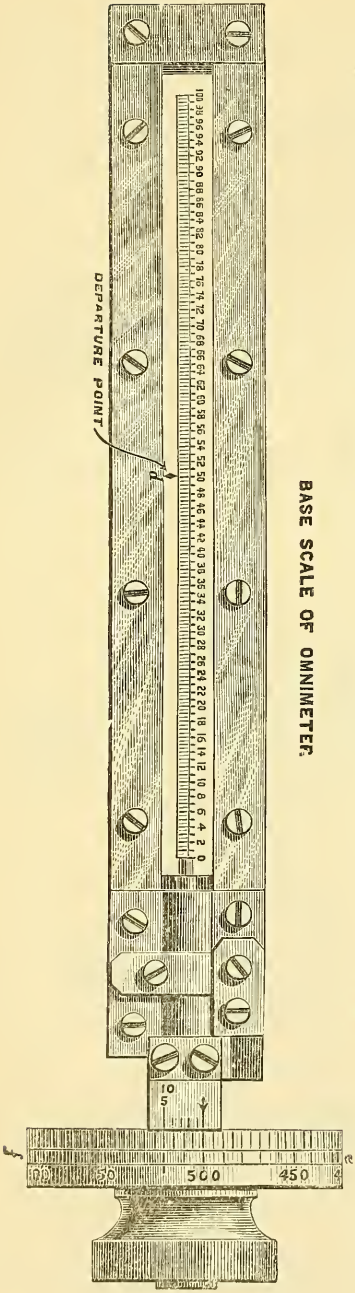

Fig. 2.

Fig. 2 illustrates this scale as formerly constructed, being divided into 100 equal numbered parts, each numbered part halved by an unnumbered line. Departure point on the new scale is 32.

The scale *AB* can be moved backwards and forwards, and one turn of the micrometer screw moves it just one of these 128 divisions. The drum *ef* of the micrometer screw is divided into 100 equal parts by lines properly marked and numbered; each of these 100 parts is divided into 5 equal parts by means of a vernier; hence the four-inch scale *AB* is accurately divided into 64,000 equal parts, each part equal to $\frac{1}{16000}$ of an inch.

Linear distances and altitudes are obtained by this instrument, by one and the same operation, with greater precision than by chain, level or any other known means.

A level *hi* (Fig. 1) is fixed on the telescope *cd*, so that the axis of the telescope may be placed parallel to the divided scale *AB*.

A magnetic needle having a play of about 15 degrees is also attached to the telescope. This serves to check courses.

The divided circle *kl* fixed to the common axis *O* is employed, as in the theodolite, to take vertical angles.

To understand the mathematical principle upon which this instrument is constructed, the operator requires but a small amount of geometrical knowledge.

In Fig. 3, *O* is the centre point of the axis of rotation directly over the divided scale *AB*; *Ob*,

the base line of the instrument, which may be found by experiment or calculation; *mn*, a staff of known length, say 10 feet; *b*, the departure point of the scale, when the telescope is parallel to *AB;* in this position, from the nature of the construction, the microscope points in the direction of the line *Ob*, which is perpendicular to *AB*. Then, if the telescope be pointed to *m*, the microscope will be directed to *m′*, the line *Om′* being perpendicular to the line *Om*. Again, if the telescope be directed to the point *n*, the microscope will be in the direction of *On′* and perpendicular to *On*. *OEm* and *Obm′* being similar right triangles with *mn* and *m′n′* homologous lines in each respectively,

$$\mathrm{m'n'} \ : \ \mathrm{mn} = \mathrm{Ob} \ : \ \mathrm{OE}$$

OE being the distance from the perpendicular line *mnE* passing through the staff *mn*,

$$\therefore \quad \mathrm{OE} = \frac{\mathrm{mn} \times \mathrm{Ob}}{\mathrm{m'n'}};$$

$$\mathrm{m'n'} \ : \ \mathrm{bn'} = \mathrm{mn} \ : \ \mathrm{nE},$$

consequently the altitude $\mathrm{nE} = \frac{\mathrm{mn} \times \mathrm{bn'}}{\mathrm{m'n'}}$ or $\frac{\mathrm{bn'} \times \mathrm{OE}}{\mathrm{Ob}}$

The perpendicular *Ob*, which is termed the base line of the

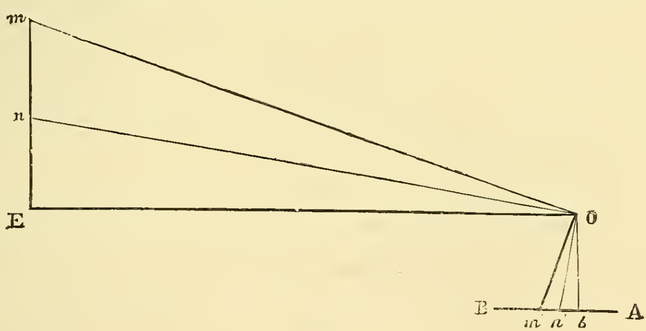

Fig. 3.

instrument, may be found, when the temperature is not very variable, by taking *OE* about 100 feet and placing the 10-foot staff *mn* as shown in Fig. 3; then $\mathrm{Ob} = \frac{\mathrm{m'n'} \times \mathrm{OE}}{\mathrm{mn}}$. By careful construction, *Ob* is made to contain 100,000 parts of the micrometer scale, or is exactly $6\frac{1}{4}$ inches in length.

Method of Operating with the Omnimeter.

1. Place the staff in a vertical position at one extremity of the line to be measured and the instrument adjusted at the other end, care being taken that the micrometer of the instrument be set at zero.

2. Point the telescope to the upper line on the staff m, clamp the telescope thus directed, and then look through the microscope to find what line on the scale *AB* falls exactly between the two fine hair-lines of the microscope. Suppose the division numbered 39 to fall between these two lines, 39,000 would represent the position on the scale to which the microscope is directed; for 39 stands for 39,000 parts out of 64,000, into which the scale is divided. Should the hair-lines fall on an unnumbered division of the scale *AB*, for example, on the division between 39 and 40, then 500 must be added to the lesser of the two numbers, and 39,500 would represent the position of the point on the scale *AB*, determined by the microscope, while the telescope is directed to the upper line of the staff. But let the operator pay special attention to the case which usually presents itself in practice. Suppose the hair-lines of the microscope fall between a numbered and an unnumbered line on the scale *AB*, that is, between the numbered line 40,000 and the unnumbered line 39,500, the scale must then be pressed *forward* by turning the micrometer drum head *to the right* until the line 39,500 comes between the hair-lines of the microscope. Suppose the scale on the micrometer drum head to read 235, that number must be *added* to 39,500, then the position of the required point *m′* on the scale *AB* is designated by the number 39,735. The readings on the micrometer drum are + for elevations and — for depressions. After each operation the micrometer circle should be turned *to the left*, *back to 500*, to prevent any mistake.

3. The telescope and microscope are unclamped, and a similar operation must be performed with respect to the lower line on the staff *n*. The staff must not be moved until the second observation is made; the first position and adjustment of the instrument are retained, allowing the telescope and microscope to move in the same vertical plane. Let the second reading at *n′* (Fig 3) give 38,015.

Let m′n′ = 39,735 — 38,015 = 1,720, as in the example we have taken, and suppose the staff *mn* = 10 feet between the upper and lower lines; *Ob* = $6\frac{1}{4}$ inches (by construction) = 100,000 parts when the four-inch scale contains 64,000 such parts.

$$\therefore \mathrm{OE} = \frac{\mathrm{mn} \times \mathrm{Ob}}{\mathrm{m'n'}} = \frac{10 \times 100{,}000}{1{,}720} = 581.3953 \text{ feet.}$$

Hence for calculating horizontal distances, we have the following rule: —

Multiply the length of the staff in feet by the length of the base of the instrument in micrometic equal parts, and divide the product by the difference of the two micrometer readings (of the staff); the quotient will be the required distance in feet.

When the length of the staff is 10 feet, this result is obtained by taking 1,000,000 times the reciprocal of the difference of the two micrometer readings.

Any error in the departure point may be easily removed by holding the milled head tightly between the thumb and finger, and turning the drum *ef* to the right or left until the departure point is brought midway between the two fine hair-lines of the microscope; if too tight to move, loosen the screw of the milled head a little, taking care to tighten it again when set right. *The instrument* must first be carefully levelled.

In the above example, the difference between the lower reading of the rod and the departure point being 16,015,

$$nE = \frac{10 \times 16{,}015}{1{,}720} = 93.110468$$ = elevation in feet of the lower line of the staff above the axis of the telescope.

Hence, for calculating altitudes, we have the following rule: —

Multiply the length of the staff in feet by the micrometic distance bn', between the point of departure b and the reading of the lower mark of the staff n', and divide the product by the difference of the two micrometer readings of the staff; the quotient will be the required altitude, the datum level being the axis of the telescope.

Heights are termed positive or negative, according as the readings on the scale *AB* are greater or less than 32,000, the reading which designates the departure point.

The scale *AB* is not required to be of any particular length, provided the dividing corresponds to the thread of the micrometer screw and *Ob* be a convenient multiple of the scale unit. Consequently, any English or foreign unit of length may be used in the construction of the "Omnimeter," as the length of the staff and the distance measured do not depend upon the unit adopted in the instrument. Different modifications may be introduced to suit particular requirements.

Practically, the omnimeter has been found very accurate. The principal tests to which it has been put are as follows: —

A survey of a plot of nearly sixteen acres was made, using the ordinary instruments, — transit, chain, tape, etc., — and levels of the courses were taken. This operation, which took considerable time, was carefully repeated. The omnimeter was then adjusted, and, without being moved from the spot, observations were taken to the top and bottom lines on the staff placed at the extremity of each course, also the angles between the lines of observation were noted, a work which occupied, comparatively, only a short time. From these data were calculated the lengths and bearings of the several courses, the area of the plot and the levels

of the points of observation, all of which practically coincided with those of the first survey. The readings should always be repeated. To check the work, the omnimeter was adjusted in another spot and the observations were repeated. The variation between the two omnimeter surveys was less than that between the two ordinary surveys, showing that when the base line of the instrument, *Ob*, is accurately known, the instrument may be depended upon for very exact work.

Heights measured by a plumb line and by the omnimeter have been found to coincide almost exactly.

Another test showing the wonderful accuracy of the instrument was a survey of a polygon over undulating ground of more than one and a half miles circuit. Upon returning to the starting-point and calculating the distances, the errors in latitude and departure were found to be 4.3 feet and 3.7 feet respectively, while the error in elevation was only 0.13 feet.

For city surveying, in laying down transverse lines, all chaining is done away with; horizontal angles and levels are taken at one and the same operation.

For railway and irrigation purposes, also for surveying and levelling in rough, hilly and thickly wooded countries, only those who have been obliged to use the surveyor's transit and chain in such places can understand the value of this instrument over others similarly employed.

PLANT DISEASES.

BY PROF. GEORGE E. STONE.

The relation of botany to agriculture assumes more importance to-day than at any previous time in its history. Only a few years ago it was believed and taught in this country that a knowledge of the parts of a flower, together with a superficial knowledge of a few hundred plants, consisting largely in a mere memorizing of Latin names, was sufficient for any purpose which the science might demand. To-day, however, this idea no longer prevails. No botanist that is at all conversant with the results of modern research can be found holding such views.

A knowledge which is confined simply to the names of objects would hardly pass now for scientific knowledge; on the other hand, it is generally admitted that the student who has studied the anatomy and physiology of one plant thoroughly possesses a better knowledge of botany than the one who has mastered the Latin names of a thousand plants.

With the introduction of the new methods of study which are represented in our higher institutions of learning by seminaries, laboratories and research, which a noted author has recently styled "the coming method," there has come an impetus to all sciences which has been of the greatest scientific as well as practical value.

As one of the results of the research and laboratory methods of study, all sciences have been brought into closer relations to each other.

Botany, for example, has not only been brought into closer relationship with such sciences as zoölogy and chemistry, but it has especially been drawn into more intimate connections with scientific and practical agriculture.

It does not require much elucidation to show how chemistry and vegetable physiology are, on the one hand, brought into closer contact in the study of plant foods, assimilation, etc.; while on the other hand, vegetable pathology and entomology, with which it is intimately connected, are both striving with the numerous enemies which attack plants, whether in the greenhouse, on the farm, in the nursery, garden and orchard, and are brought

into the most practical and beneficial relations to a large, important and fundamental industry.

It is this latter branch of work in the line of vegetable pathology which has brought botany into very intimate connection with the farmer, and affords aid of the most practical and inestimable value. This branch of botany has made such enormous strides that no intelligent and industrious agriculturist, floriculturist or horticulturist can afford to ignore the results of the manifold investigations which have been pursued so diligently within the last few years. Many years ago the illustrious chemist, von Liebig, saw the importance of this when he stated that "The scientific basis of agriculture embraces a knowledge of all the conditions of vegetable life;" and in a like manner did Dr. Lindley, the former editor of the "Gardeners' Chronicle and Agricultura Gazette," when he declared that "Good agriculture and horticulture are founded on the laws of vegetable physiology."

Much has been done since the days of these illustrious pioneers, and at present we can say more truly that vegetable pathology and physiology are the two most important divisions of botany relating to agriculture, for, according to Prof. H. Marshall Ward, the eminent English botanist, "The time is rapidly approaching when a farmer or gardener will as little dare to neglect the study of the physiology and pathology of plants as a surgeon dare practice without a knowledge of anatomy, or a sailor hope to become a captain without studying navigation."

The fungous diseases of cultivated plants cause annually an enormous loss to American agriculture, a large proportion of which might be prevented by the use of remedies which are known to be effectual. According to the United States report of the secretary of agriculture for 1892, "A recent computation made from the data furnished by vine growers in only a limited portion of the United States, based upon what they had saved by the use of a single mixture, according to rules laid down by the division, showed that the benefits for that one season to their industry alone had a money value far in excess of what the division of vegetable pathology had cost the government since its organization."

In some years the blast to wheat and corn alone by fungous diseases is estimated at $200,000,000,* and that caused by various diseases of the peach, notably the so-called yellows, must be enormous. It is estimated that four diseases of the orange and lemon cause annually an aggregate loss of fully $250,000; † and,

* Commissioner of Agriculture Report, 1886.

† Secretary of Agriculture Report, 1892.

according to a recent report on the new California vine disease,* the loss has reached the enormous sum of $10,000,000.

Many other cultivated fruits and vegetables might be cited which fall a prey to fungous enemies, to say nothing about the insect pests that cause annually very large losses to our agricultural industries. Most of our plant diseases are of recent origin, and the number of new ones which occur — some of which are extremely disastrous — render it difficult indeed to keep pace with the advancing knowledge.

For example, the orange blight, now afflicting Florida, has come to public notice only within the last three years. The vine disease of southern California, which has previously been mentioned, and which blasted so many of its vineyards, was unknown a few years ago. The carnation rust, which was introduced from Europe, was first noticed in this country by Prof. J. C. Arthur about six years ago, and is now causing considerable trouble to our floriculturists. The pear blight commenced to show its ravages only a few years ago, and the peach yellow, though well known for many years, has only shown its universally disastrous effects within the last two or three decades; in short, it may be said that the greater number of diseases which are peculiar to our cultivated plants have made their appearance, or at least have assumed disastrous proportions, within the last twenty-five years.

Some few exceptions to this statement, however, must be noted here. The corn smut, which never appears to cause a very large amount of destruction, at least here in New England, has probably existed from time immemorial; and so likewise has the wheat been subject to troublesome diseases for a very long time here in Massachusetts. Even as far back as 1754,† "An idle opinion obtained among the vulgar that since the execution of the Quakers [1659] wheat has always blasted" is sufficient to show that the early settlers were much vexed with the presence of a plant disease; and a perusal of the lengthy sermons and prayers of those by-gone days would occasionally reveal to us the sincere pleadings addressed to a Divine Providence for a deliverance from these pests. It appears from historical records that wheat has never done well in Massachusetts, as a rule, though this is not entirely due to its blighting, but to other causes. Dr. Timothy Dwight, in his travels, published in 1824, says, "In the western part of Worcester County wheat cannot be cultivated, although in some of the eastern portions it grows quite well." He further

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* The California vine disease, Newton B. Pierce, 1892.

† Neal's "History of Massachusetts," 1754.

adds, "The barberry bush is not so common in Worcester County as in the eastern counties, and this is not due [that is, the growth of wheat] to the fact that the barberry was early cultivated in the east, but to difference in soil;" and he continues, "The barberry east of Marlborough occupies a fourth of the surface of the fields." It has been believed in New England for a century or more that the barberry bush is in some way connected with the blasting of wheat. According to Dwight, "Wheat near the barberry was always blasted, and always in the direction of the wind;" and in another place he states, "The barberry bush in New England was generally believed to blast both wheat and rye, through the very copiously emitting of a pungent effluvium."

The pungent effluvium, or infectious element, we now know to be nothing more nor less than the manifestation of the normal processes of reproduction and propagation which take place in the life history of this fungus, known as Puccinia graminis; and, with due respect to the metaphysical speculations and unphilosophical deductions of our revered though well-meaning ancestors, we must add that it is now generally believed that the blasting of wheat has ever had but little connection with the persecution of the Quakers in 1659, but is due to wholly natural causes, which manifest themselves in diversified form, according to the unusual changes of condition in our environment.

* Puccinia graminis passes its ecidium stage on the barberry in the spring and early summer, and its uredospore and teleutospore stage on wheat and rye in late summer and fall. This habit, which many of our disease-causing fungi possess, of passing their different stages of development on different plants, is quite peculiar, and is known as polymorphism. Thus the apple rust, another destructive organism, passes one of its stages of development on the cedar, where it produces excrescences known as the "cedar apple;" and the other — the most injurious form to our fruit grower — is passed on the leaves of the apple. And so with our Aecidium grossulariæ, Schum, which we shall call attention to later on, the aecidium stage is passed on the leaves and fruit of the gooseberry, but in this instance the uredospore and teleutospore stages have not as yet been discovered.

It must be borne in mind, however, that it is not merely the cure of plant diseases with which we have to deal, but with the vastly more important details connected with their prevention;

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* The fungus attacking the wheat has long been known in Europe as Puccinia graminis, one stage of which is common on the barberry in Spain; but recent investigation has led some to believe that our fungus is not in every instance the European Puccinia graminis, but Puccinia rubigo-veru (D. C.) Wint.

and this implies the introduction of more rational ideas in our methods of cultivation. With the varied success which has accompanied the use of fungicides, these preventive factors are likely to be lost sight of. The ever-increasing number of new diseases which occur year after year point out to us very clearly that there is something decidedly wrong in our methods of cultivation. It is only necessary here to call attention to the so-called "œdema," a dropsical disease which occasionally occurs on tomatoes when cultivated under glass, and which is caused by the exceedingly abnormal physical conditions in which the plants are placed. We do not consider it in the least an exaggeration when we state that the greater majority of our plant diseases have their origin in defective methods of their care and surroundings. In the lack of many of the pathological conditions of our plant life there lie physiological disorders that are not so readily recognized because they are so much more difficult to observe and are so much less understood. These are the conditions that have been so little investigated, and here is a field in which much of our future work must be done; for, until we know more about these primary causes, we cannot expect to lessen the susceptibility of our plants to disease.

It is a recognized fact among vegetable physiologists that every plant is endowed with a certain inherent vital power which we cannot go beyond. We can, for example, greatly modify an organism along certain lines, but always at the expense of some other portion of the individual. If, however, we apply these modifying forces too freely and develop the plant too much in a certain direction, we weaken the organism in some other direction, and as a result it is more likely to fall a prey to some fungous disease. Every acceleration in one direction is correspondingly associated with a retardation in another. One experiment, taken from a number which we have made, is sufficient to illustrate this point. If, for example, we cause a plant to be slightly cut or injured in any way, there always occurs immediately after a retardation in its growth, but this is associated with an acceleration or increase in the respiration.

The phenomena accompanying these changes which take place in an organism are designated by physiologists as correlation, and so intimately connected are all the cells, tissues and organs of a plant with one another, or, in other words, so manifestly correlated are they, that anything, such, for example, as a cut, scratch, insect sting, changes in temperature, moisture, etc., act as stimuli, and set up in the plant a series of changes which modify — according to the nature and strength of the stimuli applied — the subsequent growth of the organism.

The stimulative factors which all cultivators of plants under glass have to contend with are mainly moisture, heat and plant foods. In the application of these factors the inherent vital properties of the plant must necessarily be taken into account. The minimum, optimum and maximum moisture and heat conditions should be known, and improper food should not be applied so as to cause starvation, or to develop the plant too much in one direction or beyond its limit of power.

Ill-advised and quick fertilizers are coming now to be considered as constituting no small factor in the unhealthy conditions of plants. Besides these, there are other factors of no less importance which should be carefully guarded against, such as too sudden changes in temperature, improper ventilation, insufficient light and improper drainage, irregular and over watering, which lead to unhealthy conditions of the soil. It is the proper dealing with these factors that constitutes what is known as skill, and the intelligent working out of the problems attending these factors belongs as much to the instinctive perceptions of the practical floriculturist and gardener as they do to the experimental acumen of the horticulturist and botanist.

It is our purpose in the remaining part of this paper to consider a few of the plant diseases which have mainly been brought to our notice during the past year at the Agricultural College.

Carnation Diseases.

The Carnation Rust (*Uromyces caryophillinus, Schrank*).

During the past year the carnation rust was quite abundant in our greenhouse, as a result of which the foliage of the carnations was much injured and the plants greatly disfigured. The carnation rust first makes its appearance as elevated ridges about one-eighth to one-fourth of an inch long on the surface of the leaves, through the epidermis of which a reddish-brown powdery mass — the reproductive bodies — eventually breaks. This reddish-brown powdery mass is nothing more nor less than the spores, or, more properly, the uredospores, which are of a reddish-yellow color when observed singly under the microscope, and whose function it is to propagate the fungus, which they do very quickly and most effectually.

The uredospores are the terminal outgrowth of a mass of filaments or vegetable threads called the mycelium, which ramify promiscuously between the cells of the underlying tissues of the leaf, and which throw out innumerable little suckers called houstoria, by which organs the fungus takes its nutriment from the

host plant. The spores have a spiny covering, are about 1-50 mm. in diameter, and are connected with the terminal filaments by a short stalk. From what has been stated, it must be evident that it is the penetration of the houstoria into the cells and the utilization of the cell contents which cause the injury to the carnation plant; but, inasmuch as the method of treating the disease is a preventive one, the remedy must be applied at the very beginning, — that is, before the spores have germinated.

Fortunately, the experience of a number of floriculturists, which accord with the rather limited results obtained by Professor Maynard at the Agricultural College, has shown that the carnation rust can be prevented by the use of the Bordeaux mixture in a dilute form if applied upon the very first appearance of the disease. The spores germinate readily wherever there is moisture, and some experiments have recently been made by the writer to ascertain whether they would germinate in the presence of the Bordeaux mixture in various strengths. For this purpose an equal number of drops of a normal solution* and others having a strength of $\frac{1}{2}$, $\frac{1}{4}$ and $\frac{1}{8}$ of that of the normal strength were placed on microscopic slides over equal areas and allowed to evaporate. With these precautions the residue left after evaporation would bear proportional relations to the degree of dilution, and tolerably accurate results would be obtained. After the evaporation had taken place a number of uredospores were placed on each slide containing the dried residue left by the solution, and a cover slip which rested on two strips of moistened filter paper was placed over each, thus forming a moist chamber. These slides were then placed under a bell glass to await the results, which were as follows: —

Normal solution, no spores germinated.

$\frac{1}{2}$ normal solution, . . .	no spores germinated.
$\frac{1}{4}$ normal solution, . . .	many spores germinated.
$\frac{1}{8}$ normal solution, . . .	many spores germinated.

From these results it would appear that possibly a solution equal to one-half the normal strength might be applied effectually.

The Carnation Leaf-spot (*Septoria dianthi*, *Desm.*).

This disease, like the rust, has for a long time been well known in Europe, and has shown itself during the last year on the carnations at the college, but not in so disastrous a manner as reported

* The normal solution used here is the fifty-gallon Bordeaux mixture, containing four pounds copper-sulphate, four pounds lime and fifty gallons of water.

elsewhere. It can be easily distinguished from the rust by its usually circular purplish outline, in the middle of which there is a whitish spot filled in with a few minute dark points that constitute the fruiting conceptacles.

This disease occurs not only on the leaves but also on the stem, where it is reported as doing considerable damage both to the stem and flowers, preventing the latter from opening. The imbedded filaments or mycelium in this case do not develop houstoria, but pass directly through the cells, thus robbing the host plant of its nutriment without the aid of houstoria. The fungus is propagated by septate colorless spores which are found in conceptacles near the surface of the leaf. The use of some of the well-known fungicides is recommended for the prevention of this disease.

Anthracnose of Carnations.

Accompanying the carnation rust and leaf-spot is frequently to be seen a disease called the anthracnose. It has been occasionally met with on the carnations at the college, but never very abundantly. The disease shows itself as depressed areas on the surface of the leaves and stems, which are caused by the growth of the fungous filaments. These areas are filled in with minute black fruit dots, consisting of black, sharp-pointed hairs, between which are produced the spores. According to Dr. Halstead of the New Jersey Experiment Station, this fungus is exceedingly susceptible to moisture, and is especially injurious to the lower leaves, where the transpiration is incomplete.

Other diseases of the carnation which have caused more or less trouble have been described in various periodicals. Among these are the so-called fairy ring spot (Heterosporium echinulatum (Berk) Cooke), which is said to be a recent importation from England. We have observed this on several plants at the college, apparently doing no serious harm. The disease appears on the leaves in small circular spots, in which are to be seen, with a magnifying glass, the fruiting bodies, bearing brown, septate, spiny spores.

The carnation leaf mould, a fungus which sometimes covers the whole plant with a growth of mould.

The carnation rosette, supposed to be caused by a species of Fusarium, a mould-like organism.

The purple joint, a bacterial disease, discovered recently by Dr. J. C. Arthur, and the damping fungus (Botrytis vulgaris), occasionally attack the carnation, as they do many other plants under glass, wherever the air is too warm and moist.

Diseases of the Rose.

Powdery Mildew (*Sphærotheca pannosa* (*Walh*) *Lev.*).

The powdery mildew of the rose is associated with conditions in our greenhouse roses that are quite common and troublesome, and is perhaps so well known to all of our florists — it being so characteristic and easily discernible with the naked eye — that any description of it is unnecessary. The mycelium, which forms a minute compact white mass upon the surface of the leaves, causing them to crinkle, produces chains of spores (conidia) which are capable of propagating the fungus with the greatest facility; and thus, if the conditions are favorable, the disease can make its appearance at very short notice. Most gardeners believe that the rose mildew is brought on largely by a weakened condition of the plants, by exposure to currents of cold air, etc ; consequently the minutiæ attending the working of the normal physiological function of the plants cannot afford to be neglected.

The best remedy for the disease when well established is that proposed by Professor Maynard, who has had long experience in growing roses and experimenting with different fungicides. He recommends the use of sulphur boiled in a kettle over a kerosene stove for two or three hours twice a week, the only precaution being to use no more heat than is sufficient to boil the sulphur. Another method is to run the temperature up to 75°, and with a bellows fill the house with sulphur. The house is kept closed until the temperature reaches 85° or 90°, after which air is let in gradually. Potassium sulphide, one ounce to two gallons of water, has also been used with success as a spray.

Rose Rust (*Phragmidium subcorticium* (*Schrank*) *Wint.*).

This fungus is not unfrequently found on our hardy roses, and we have had our attention called to a number of affected leaves during the last season. So far as we know, however, it never does any serious harm here in Massachusetts, although in California it becomes an exceedingly troublesome pest. This fungus passes through various stages of growth that are peculiar to the wheat rust. It makes its appearance early in summer upon the leaves as yellow spots, known as the aecidium stage; and this stage of development is followed in later summer and early autumn by the uredospore stage, which is characterized by different kinds of spores, producing a darker streak of red. In the fall still another form of spores makes its appearance, known as the teleutospores, or the so-called winter spores. These are dark-brown septate bodies,

furnished with stalks, which are grouped in masses on the under surface of the leaves, and appear to the naked eye as black dots about one-sixteenth of an inch in diameter. No fungicide, so far as we know, has been applied to this disease with success.

Gooseberry Rust (*Æcidium grossulariæ, Schum.*).

Specimens of gooseberry leaves and fruit bearing this fungus to a considerable extent have been sent to the college during the past summer, and some of the unsprayed bushes in the college garden showed the same disease.

The fungus is readily recognized with the naked eye as forming bright yellow cups about three-sixteenths of an inch in diameter, which occur in groups in swollen portions of the leaves or berries. In outward appearance as well as in its internal structure it resembles the cups produced on the leaves of the barberry, and, like the fungus which attacks that plant, this cluster-cup stage, with its spores or conidia, known as the æcidium stage, is supposed to form a cycle in its complicated life history. The other stages of this fungus are not known.

No remedy has been suggested for this trouble except that of burning out the cups before they have burst open and have discharged their spores; but this method appears impracticable.

Powdery Mildew (*Sphærotheca mors-uvæ (Schu.) B. and C.*).

This fungus belongs to the same large group as the rose mildew and grape mildew, and is not unfrequently found doing considerable damage in Massachusetts. The treatment recommended by Professor Maynard for all diseases of the gooseberry, as well as the currant, is first the Bordeaux mixture, containing Paris green, one pound to two hundred gallons, to be followed by the use of powdered hellebore and Persian insect powder, and if necessary by ammoniacal carbonate of copper. When Paris green is used the solution should be applied before the fruit sets, otherwise serious poisoning might result. For further details consult Bulletin No. 25 of the Hatch Experiment Station, which contains much valuable information in regard to the treatment of many of our fruits.

Club Foot of Cabbage, Turnip, Cauliflower, etc. (*Plasmodiophora brassicæ*). (*Wor.*)

The trouble arising from this disease to cabbage, turnip and cauliflower is unfortunately too well known to our farmers and market gardeners. The cause of this trouble is due to a represent-

ative of one of the lowest forms of plant life, termed by botanists myxomycetes, and is, moreover, the sole representative of this class which is as yet known to cause any serious disturbance to our economic plants. So low in the scale of life is this organism that it does not even produce a cellular or filamentous structure, but, on the other hand, it consists in its plasmodic stage of simply a mass of gelatinous slime. This is the stage which the fungus is in when the host plant first commences to show the effects of the club foot, that is, in early summer, at which time the affected cells are filled to extension with a slimy mass. Later on in the season this slimy mass completely breaks up into spores, which are subsequently set free by the rotting of the roots, by which process they are left in the soil, anxiously waiting for another similar crop to be planted the next season. In the spring these spores germinate, but not exactly the same, however, as other spores do, inasmuch as they form zoöspores, that is, motile spores, which move about by means of cilia; and when the proper host plant offers itself (as the cabbage or turnip), they penetrate the thin-walled cells of the roots and coalesce to form another plasmodium or slimy mass.

Like all diseases that are peculiar to roots, it is difficult to treat with any fluid mixture. A preventive, however, for the club foot is said to be found in the rotation of crops; but there seems to be some doubt cast on the efficacy of this preventive since Dr. Halstead* has discovered the club foot on the roots of one of our most common weeds, the shepherd's purse. Other treatments are also recommended, such as the use of lime at the rate of seventy-five bushels to the acre, and also by the application of carbon-bisulphide to the seed and soil.

The Potato Scab (*Oöspora scabies*, *Thaxter*).

For the many facts concerning our knowledge of this troublesome disease which have been added within the last few years we are largely indebted to the careful investigations of Dr. Thaxter, formerly of the Connecticut Experiment Station. This disease is now known to be caused by a fungus bearing the above name, and it is further believed that the spores of this fungus are to a great extent introduced into potato fields by the use of barn-yard manures coming from stock which has been fed on diseased potatoes. These preventive measures have therefore been recommended in planting: (1) the seed must be free from scab; (2) no land should be planted with potatoes which has previously produced scabby crops; (3) scabby potatoes should not be fed to

* Torrey Bulletin, February, 1894.

stock; (4) fertilizers are preferable to barn-yard manure; (5) dig the potatoes as soon as mature, if scab is present. Many recent reports favor the use of corrosive sublimate for the seed potatoes, of the same strength as that used in surgery, namely, one part in one thousand. This solution is made up as follows: dissolve two ounces of corrosive sublimate in two gallons of warm water, allowing it to stand for a few hours, and then dilute to fifteen gallons. After this has been completely dissolved, immerse the cleaned potatoes, and allow them to stand in the solution for about one and one-half hours, after which draw off the solution into another non-metallic vessel, and allow the potatoes to dry, when they can be planted as usual. This solution can be used a number of times; but it must be remembered that corrosive sublimate is a deadly poison, and care must be exercised in handling it.

Fruit Mould of the Peach, Plum and Cherry (*Monilia fructigena*).

This fungus always shows itself on some of the fruit of the peach, plum and cherry, and whatever it attacks is rendered entirely useless. This fungus is represented to be the most common as well as the most disastrous of any which attacks the peach. It not only attacks the fruit, but also the leaves, flowers and frequently the branches which support the fruit. It first makes its appearance as brownish circular spots on the side of the fruit; this rapidly enlarges until the whole fruit becomes a brownish or reddish color, and eventually it gradually shrivels up.

Satisfactory results have not always been attained by the use of fungicides on fruit affected with this fungus. Mr. B. T. Galloway of the United States Department of Agriculture obtained negative results with the use of the Bordeaux mixture, while Professor Chester of the Delaware Experiment Station, with the use of a thirty-seven-gallon formula of the Bordeaux mixture, after six applications, reports a saving of thirteen and nineteen per cent respectively. Professor Maynard, however, has obtained much more favorable results with the use of the ammoniacal carbonate of copper solution; and for a detailed account of this method of spraying the reader is again referred to Bulletin No. 25 of the Hatch Experiment Station.

Damping Fungus (*Botrytis vulgaris, Fr.*).

One of the most common and troublesome fungi of the propagating pits is the so-called "damping fungus." This is caused by a mould-like organism called Botrytis vulgaris, and in some

instances by a very similar organism, at least in one stage of its development, known as Pythium De Baryanum.

From a number of cultures which have been made in the botanical laboratory from material obtained from damping off plants in the greenhouse, it has been shown, by the characteristic stages of development which it passed through, that the organism causing this difficulty with us is the Botrytis vulgaris.

Cuttings of begonias, verbenas and coleus are especially subject to the depredations of the Botrytis, and it also causes more trouble in lettuce cultivation under glass — producing a disease known as the leaf-rot — than any other fungus. It is a question among botanists whether this fungus is ever a parasite, that is, whether it is really the cause of the abnormal conditions with which it is associated. Most observers believe that the phenomena in question are first caused by the unhealthy condition of the surroundings in which the plants are placed, that is, by too much moisture accompanied by too high a temperature, and that the fungus is merely a secondary cause of the destruction. It has, however, been observed that by guarding against the extreme moisture and temperature conditions of the greenhouse, damping becomes much less prevalent; consequently the successful florist is one who will carefully consider such details.

Bacterial Diseases.

Every now and then a new bacterial disease is reported as causing considerable damage to plants; but much thorough work must be done before we know just how much these minute organisms are responsible for the trouble which they are said to cause. During the latter part of last fall many of the strawberry plants in the college plats showed signs of decay just at the time when the conditions of the atmosphere were most favorable for such growth; and an examination of the leaves, notably the lower ones, showed them to be shrivelled, and the cells of the petioles to be filled with bacteria. This abnormal condition, however, was confined to certain varieties, some of which recovered, while others died.

Some other diseased plants laden with bacteria were brought to our notice during the past year, although in every instance the presence of these organisms appeared to be the result of unhealthy conditions.

The bacterial diseases which are the best known are the fire-blights of the pear, apple and quince. Bacterial diseases have also been observed in connection with the beet, blackberry, celery, corn, lettuce, raspberry, potato, cotton, cucumber, melon, carnation, tomato, squash, oat, sorghum, salsify and olive.

Nematode Worms.

Diseased plants containing these small, eel-like animals have been sent in to the college more frequently during the past season than any other kind. The consideration of these pests naturally belongs to the department of zoölogy; but, as a matter of fact, plants infested with these parasites are invariably sent to botanists, under the impression that the disease is caused by some species of fungi.

Cucumbers which have been forced under glass under conditions which are extremely abnormal to the plant are the most susceptible to the attack of nematode worms; any injury to the roots, whether mechanical or arising as a result of abnormal conditions which cause weakening of the tissues, etc., renders the root likely to fall a prey to these parasites. It appears, moreover, that they are capable of penetrating apparently healthy and normal tissues.

When attacking the roots of the cucumber they produce abnormal growths the presence of which can usually be detected on the roots by the formation of tubercles. Microscopic examination of the tubercles shows a disintegrated tissue containing nematodes.

These parasites not only attack the cucumber but a great variety of other plants, especially in the Southern States, where they find conditions more suitable for their existence. They have also been frequently found in connection with some serious disorders affecting the rose and violet, and have even been reported as occurring in the leaves of the India-rubber plant.

Extended experiments have not as yet been made in regard to the treatment of plants affected by these pests. Lime, however, has been used with favorable results by sprinkling it on the surface or mixing it with the soil. It is known that manure is likely to be full of nematodes, and this would offer, therefore, a means of contamination. In fact, they are almost always found in unwholesome soil, and therefore the best preventive measures would be to always keep the soil in a perfectly healthy condition.

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JANUARY, 1896.

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Commonwealth of Massachusetts.

MASSACHUSETTS AGRICULTURAL COLLEGE,
AMHERST, Jan. 1, 1896.

To His Excellency FREDERIC T. GREENHALGE.

SIR: — I have the honor to transmit, herewith, to your Excellency and the Honorable Council, the thirty-third annual report of the trustees of the Massachusetts Agricultural College.

I am, very respectfully,

Your obedient servant,

HENRY H. GOODELL,

President.

ANNUAL REPORT OF THE TRUSTEES

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

His Excellency the Governor and the Honorable Council.

Feb. 20, 1895, there passed away from our midst the oldest member of our Board, one who had served continuously for twenty-six years. Daniel Needham was appointed in 1869, and from that time to the day of his death was a faithful, conscientious worker. He never spared himself when duty was to be performed, even, in his last illness, rising from his bed in a vain endeavor to keep an appointment in Boston and discuss measures of importance to the college. As chairman of the finance committee, his course was always marked by a wise conservatism. As member of the committee on experiment department, he helped outline and shape the policy which has since been pursued. At the semi-annual meeting of the trustees, held in Amherst, June 18, 1895, the following resolution, expressive of the estimation in which he was held, was adopted: —

Resolved, That in the death of Hon. Daniel Needham, for more than a quarter of a century a trustee of our Agricultural College, the Commonwealth has lost a most valued and respected citizen, who had often been the recipient of honors both from the government and the people at large. Our college has lost the oldest of our trustees, who was exceeded by no one in his earnestness in the welfare of the institution, and by his ready activity to promote, by word and deed, by wise counsels and faithful attendance, the best interests of the college.

Individually we shall miss his genial presence and his hearty greetings at our meetings, and deeply we shall feel the loss of a positive and reliable friendship.

Attendance.

It has been frequently asserted that, in times of financial trouble, the attendance at our colleges and universities shows no diminution, but is, if anything, increased. Statistics would seem to indicate that in the panics of 1873, 1884, 1890 and 1893, the numbers at Yale, Harvard, Amherst and Williams showed no falling off. However this may be the case with the so-called classical institutions, it is not so with the agricultural and mechanical colleges. These respond at once to the pressure of hard times. Their ranks are recruited, for the most part, from the classes who have no reserve capital upon which to fall back, and who are consequently compelled to recall their sons and enter them at once in the army of bread winners. The past two years have been no exception to this rule. The college has felt in a marked degree the stringency of the times. Another cause operating to produce this decrease in numbers has been the increased requirements for entrance, which went into effect last year. Out of a total of sixty-two young men applying for admission, six failed to present themselves for trial, assigning as a reason their inability to pass the examinations, sixteen were rejected, and, of the forty-one admitted, only fourteen were passed without conditions. As in previous years, the greatest deficiency was noted in the common English branches. The ignorance displayed of the very rudiments of grammar and arithmetic would almost lead to the conclusion that the grammar school had been suppressed throughout the State.

Course of Study.

Important changes have been made in the curriculum. Latin as a requirement for entrance and as a required study has been dropped. Four new electives are offered in the senior year: one of engineering and one of mathematics, under Prof. Leonard Metcalf; * and two in the department of languages, one of Latin and one of advanced English. Both of the latter will be under the supervision of Prof.

* See mathematical department, under head of equipment.

George F. Mills. In nearly every class a few members are found desirous of prosecuting the study of Latin. To give these few the opportunity of so doing, without compelling the majority to spend their time over what they do not want, this elective is offered.

It has been deemed impracticable to longer carry on the two-years course, and it has been discontinued. In its place a number of short winter courses have been substituted, all optional, all free (except minor laboratory fees) to citizens of this State, and all without limitation of entrance examination. As they are planned to offer the greatest good to the greatest number in a limited period of time, not exceeding eleven weeks, the instruction will necessarily be more or less elementary in its character, but as thoroughly practical as it can be made. Neither degree nor diploma will be conferred.

The dairy course is expected to cover such practical points as soil and crops; dairy breeds and cattle breeding; stable construction and sanitation; common diseases of stock; foods and feeding; dairy book-keeping; pasteurization of milk; composition of milk; milk testing; butter making, etc.

In addition to the above, two courses each are offered in agriculture, botany, chemistry and zoölogy, and three in horticulture, the last named naturally subdividing into floriculture, fruit culture and market gardening. Practical points taken up include the use and application of manures; growth of grains and fruits; budding, layering and grafting; plant diseases and their remedies; insecticides and fungicides; anatomy and physiology of the domestic animals, and their condition and habits. In short, the whole aim in all these courses is to present, in condensed form, within the brief limit allowed, such practical instruction in agriculture and the allied sciences as will be most helpful to the farmer. Of necessity, this arrangement of studies, as here presented, must be more or less tentative. Experience alone can determine what should be increased and what eliminated. The double courses provided permit of concentrated attention upon a single subject in one year, or of continuous study in successive years, provided the instruction commends itself as being profitable.

It has been our effort each year to give our students a course of lectures on some given subject. This year the topic was "Politics," and the subject was practically presented by Mr. Raymond L. Bridgman of Boston, for many years legislative reporter, under the following heads: —

1. Our State government; or, the people as an organism.
2. Government by the people; or, how the organism is guided.
3. Development by legislation; or, how the organism grows.
4. Progress by the ballot; or, how the weak parts of the organism are strengthened.
5. Neglect of the government; or, a constant danger to the organism.
6. Separateness and frequency of elections; or, the intensity of the organic life.

The Faculty.

The resignations of Prof. Clarence D. Warner, who for ten years held the chair of mathematics and physics, and of A. Courtenay Washburne, the assistant professor of mathematics, necessitated an entire change in that department and a partial reorganization of the course of study. The position made vacant by the withdrawal of Professor Warner was filled by the election of Leonard Metcalf, B.S., a graduate of the Institute of Technology, Boston, in 1892. An accurate, thorough scholar, and an enthusiast in his profession, he brings to his chair a practical knowledge of his subject, derived from a three years' experience in the engineering office of Wheeler & Parks, Boston. Professor Washburne's place was made good by the election of Philip B. Hasbrouck, B.S., a graduate of Rutgers College, New Jersey, in 1893. Dr. James B. Paige, professor of veterinary science, having received a year's leave of absence, for the purpose of familiarizing himself with the latest methods of bacteriological investigation practised abroad, left in July. Instruction in his department has been given by Dr. Eugene H. Lehnert, a graduate of this college in 1893 and of the veterinary school of Magill University, Canada, in 1895.

Expenditure of State Appropriations.

The several amounts appropriated by the State have been expended judiciously and for the purposes intended. Two hundred dollars, found inadequate for the enlargement of the botanical laboratory, has been covered back into the treasury of the State. An entomological laboratory, thirty-two by thirty-six feet, containing stands and appliances for sixteen students, was erected and immediately utilized. This much-needed addition to our equipment allows us to offer first-class instruction in entomology, and facilities not to be found elsewhere.

The erection of a gun room, twenty-eight by sixty feet, with shooting gallery for practice during the winter months, enables us to comply with the conditions imposed by the war department on issuing the new breech-loading steel rifles, and with the spirit of the law requiring military instruction at the college. The expenditure for stock is detailed elsewhere in the report of the agricultural department.

On the 11th of September a storm burst upon the college, surpassing in fury any heretofore recorded. "With a normal though slightly falling barometer, temperature of 84°, wind from the south-south-east, and a clear sky, suddenly, about three o'clock in the afternoon, there came from the north-east a hurricane accompanied with blinding sheets of rain, bright flashes of lightning, and terrific gusts of wind, reinforced by a steady gale and mass of hail. For nearly twenty minutes the storm fairly raged, but had spent itself at the end of half an hour, when the wind ceased and the sun shone brightly. The gale had left a record of a velocity of ninety-three miles per hour, a sudden fall of 14° in temperature, and an inch and a third of rain, fully an inch and a quarter of which must have fallen in twenty minutes. Several hailstones were found by one observer, measuring two inches in length, and one at least one and one-quarter inches in diameter."* Trees were split and broken by the storm, standing corn was blown down, and the fruit and

* From the September meteorological bulletin of the Hatch Experiment Station.

vegetables so badly damaged as to be almost worthless. Several tons of grapes were destroyed, and pears, peaches, quinces, apples and other fruits were either blown from the trees or so bruised as to be unsalable; over seven hundred panes of glass in the greenhouses were cracked or broken; the copper flashings on the roof of the chapel were rolled up like paper, and considerable slate stripped off and scattered in fragments on the parade ground. The loss footed up to about twelve hundred dollars. This extra expense, coming so near the close of the year, when all moneys had been appropriated, caused not only great inconvenience, but has compelled the college to exceed its income. It would seem proper in this emergency to appeal to the State for aid. Other subjects demand careful consideration.

First. — The horticultural department has outgrown its limits, and demands more ground for orchards and nurseries. It would seem the part of wisdom to purchase the so-called Clark property, containing about twenty acres. It is now in the market, and its position — lying adjacent to the college nurseries — makes its acquisition peculiarly desirable.

Second. — The work of the experiment station has increased to such an extent that the laboratory is no longer adequate. The rooms are overcrowded, and space cannot be found either for the workers or the appliances used. There is no shelf room available. Retorts, glass ware and delicate instruments must be left on the tables, when not in use, to their own detriment and the great inconvenience of the chemists. An easy remedy can be provided by lengthening the wings, each twenty to thirty feet, and connecting the two by a covered arch. This will secure the needed space and furnish room for storage and special work.

Third. — The mortar on the spire of the chapel-library building has so badly weathered that sooner or later pointing will be required. Whenever this is undertaken, it will involve considerable outlay for the erection of the wooden scaffolding necessary for the workmen.

Fourth. — It seems necessary to provide a proper building for a light and power station for the electric plant. Its present location is entirely unsuitable, presenting conditions

best fitted for spoiling the machinery, instead of keeping it in good working order. In the report of the engineer in charge, he says: "The location of the coal bin and boiler, in relation to the milk and other rooms of the dairy school, is bad, for there is no possible way in which the dust and soot from the boiler can be prevented from covering the floors of the room. Again, the location of the engine under the milk room and the dynamo under the barn floor renders them liable to injury from the leakage of water every time the floors are washed. Last, the location of the smoke stack, with the top almost on a level with the ventilators of the barn, and only thirty or forty feet from either, is a constant menace to the buildings, on account of the sparks that might be carried into them by a chance draft."

To recapitulate briefly, it is asked that there be appropriated: —

For loss occasioned by hail storm, ...	$1,200
For purchase of the Clark property and placing it in workable condition, ...	5,500
For extending the laboratories of the experiment department, .	7,000
For repair of chapel spire, a sum sufficient.	
For providing a suitable building for a light and power station, a sum sufficient.	

FARM REPORT.

The operations on the farm during the past year have been attended with a fair measure of success. The culture of our crops, however, constitutes an exception in some particulars. We have had some poor crops, and prices are unprecedentedly low. The most important single cause of small yields was inferior seed. The mid-summer months, moreover, were too dry for the best results in the field. The most important effect was a comparatively small yield of rowen.

The number of acres in the several crops of the year was as follows: grass, 74; potatoes, 16½; onions, 3; beets, carrots and Swedes, 1 each; corn for the silo, 23; field corn, 16½; millet, 3, and oats and pease, 2, — a total of 141 acres. In this statement six and one-fourth acres are counted twice, as a field of five acres of corn for the silo followed grass cut for hay, and another field of one and one-fourth acres was ploughed and sown to millet after the hay was removed. Then the land which produced the oats

and pease and a part of the millet land bore also a crop of barley for fodder. The total money value of the products — estimating hay at $14 per ton, corn at 45 cents per bushel, potatoes at 25 cents per bushel, small potatoes at 12½ cents per bushel, onions at 25 cents per bushel, beets at $6 per ton, carrots at $10 per ton, Swedes at $6 per ton, silage at $4 per ton and green fodder at $4 per ton — amounts to $6,148.81, — an average of $45.80 per acre. This is $2.35 per acre less than last year; but, had potatoes and onions commanded the prices of last year even, — prices which we then looked upon as very low, — the acre value of our products would have stood at $52.09, which is about $4 higher than last year. On the other hand, hay is $2 per ton higher this year than last. The net advance, therefore, on the basis of equal prices, is only about $1 per acre. Of course this point is not brought out to show a profit, because we cannot change price facts; but simply that we may have a fair basis on which to judge the results of our farming operations. On this basis we see that the productive capacity of the farm has been somewhat increased.

The acreage and products of the year were as below: —

Hay. — Total, 74 acres; first crop, weighed as put in, 166 tons and 394 pounds; rowen, weighed as put in, 38 tons and 665 pounds; average, 2.69 tons per acre.

Potatoes. — Sixteen and one-half acres; merchantable tubers, 2,577 bushels; small tubers, 350 bushels. About one-fourth of this area was the site and immediate surroundings of our old farm buildings; this could not be graded and prepared until rather too late for the best results, and the soil was not in condition to produce large crops. On about two-thirds of the remainder we used seed of our own raising, — Beauty of Hebron, — and for some reason that we cannot understand it did not come up well. Those plants which came were many of them weak, and as a consequence the yield was small. Beauty of Hebron seed from Maine, managed and planted in the same manner as the other, gave a fine crop. There was some rot in parts of the field which were moist. As a consequence of the various unfavorable conditions named, our average product is the lowest for several years; viz., 156.2 bushels merchantable and 21 bushels small tubers per acre.

Field Corn. — South slope, 8 acres; shelled corn, 640 bushels; stover, 25 tons. North flat, 5 acres; shelled corn, 225 bushels; stover cut green into silo, 35,670 pounds; fodder, 2 tons. South flat, 3 acres; shelled corn, 225 bushels; stover, 7½ tons.

Corn for the Silo. — Seventeen acres; 416,425 pounds, weighed into silo; 15 tons fodder, fed green; 40 bushels shelled corn and ½ ton stover.

Corn for the Silo, following Hay. — Six acres; 109,840 pounds, weighed into the silo.

Onions. — Three acres; 837 bushels sound onions.

Beets. — One acre; 15 tons.

Carrots. — One acre; 18 tons.

Swedes. — One acre; 7 tons. This crop was very much injured by the great hail storm.

The manures and fertilizers applied to the several crops are shown in the following table: —

Applications per Acre.

	Old Mowings.	New Mowings, Second Year.	Field Corn, on Sod.	Field Corn, on Stubble.	Corn for the Silo.	Potatoes.	Onions.	Mangolds (Beets).	Swedes.	Carrots.	Millet.	Oats and Pease.
Manure (cords), ...	–	–	4	–	5	–	–	–	–	–	–	–
Nitrate of soda (pounds), .	200	150	100	125	100	125	150	200	125	125	200	150
Dried blood (pounds), .	200	–	–	200	100	200	200	200	150	150	100	100
Dry ground fish (pounds), .	100	100	100	200	100	100	300	400	200	200	100	100
Cotton-seed meal (pounds),	200	100	100	200	–	200	150	300	300	300	200	200
Plain superphosphate (pounds).	–	–	100	200	100	400	200	300	200	150	150	100
South Carolina rock phosphate (pounds).	100	100	100	100	100	100	150	150	150	150	100	100
Sulphate of potash (pounds),	–	–	–	–	–	300	300	–	–	–	–	–
Muriate of potash (pounds),	150	150	125	200	125	–	–	600	400	400	250	350

As we were for several months without cattle in the summer and autumn of 1894, the amount of manure available for use upon the farm was much smaller than it has been for many years; we have accordingly used fertilizers to a much greater extent than in any previous year. In making the applications indicated in the above table, it was my aim to supply phosphoric acid and potash in larger amounts than the crops raised would carry away, thus accumulating a reserve store of these elements for the use of crops in future years. In supplying nitrogen, I aimed to furnish more nearly the amounts the crops carried away would contain; but I did not lose sight of the fact that the decaying sod and stubble could in some cases furnish considerable of the required nitrogen, or of the further fact that the plants of the clover family would be able to take part of this nitrogen from the air. In short, I figured closely on this element, as experience shows that it is very liable to waste, since soils cannot hold its soluble forms. In supplying nitrogen, I aimed

to furnish it in forms of differing degrees of availability. For example, for onions, nitrate of soda for immediate use, then dried blood, dry ground fish and cotton-seed meal for later use.

In the case of phosphoric acid I followed a somewhat similar rule; superphosphate for immediate use, cotton-seed meal, fish and South Carolina rock phosphates for later use and succeeding seasons. The less soluble phosphates are cheaper than the others. The potash is all furnished in the form of soluble salts, but the soil can hold potash applied in these forms, and those selected are among the cheapest available potash fertilizers. Most of these fertilizers were mixed just before use, spread broadcast after ploughing, and harrowed in. For hoed crops, as a rule, some of the more soluble materials were put in the drill.

Late Corn for the Silo. — It seems desirable to say a few words concerning this crop. The field of six acres on the campus had been in grass about twelve years, and Kentucky blue grass was the prevailing species. This produces one fair crop, but very little rowen. It seemed desirable to plough and re-seed with more productive species of grass. The grass was cut about the middle of June, and yielded two tons of hay to the acre. Ploughing was begun June 19, and the field was planted June 24–25. It received a light dressing of barn-yard manure and 5,600 pounds of wood ashes, both spread after ploughing, and harrowed in. Three hundred pounds per acre of Bradley's special corn fertilizer were drilled in with the seed, — one-half bushel of Longfellow corn per acre. The crop reached the roasting-ear stage; almost every stalk bore a good ear, and some of the earliest were beginning to glaze. It was badly torn and injured by the hail and wind, and was touched by one light frost before it was cut. The yield was nearly 55 tons, as weighed into the silo. This fodder contained about $33\frac{1}{3}$ per cent. of dry matter, having the following composition: —

Composition of Dry Matter of Late-planted Corn for the Silo.

	Protein (Per Cent.).	Crude Fat (Per Cent.).	Cellulose (Per Cent.).	Nitrogen-free Extract (Per Cent.).
Longfellow corn fodder, . .	9.15	1.65	28.96	54.92

This is very nearly as good as the average of mature (glazed) flint corn fodder.

The yield, rather over nine tons per acre, is of course not large,

but as a second crop it is a profitable one. It would undoubtedly have been considerably larger but for the severe storm alluded to. This field was sown to timothy, red top and clover early in August, and now promises good crops of hay next season.

Field Corn and Silage from the Same Field. — From one field of corn of five acres we picked the ears, throwing into light windrows on the ground. We then cut the stalks and immediately hauled to the barn and cut into the silo. More labor is involved in this system than in cutting ears with stalks into the silo. It is, however, sometimes desirable for certain classes of stock to have silage not containing grain. Under these circumstances this method appears to be a good one. The corn when the ears were picked was just glazed. The ears cured very well upon the ground, but the grain is undoubtedly somewhat less plump and heavy than under the ordinary system of stooking. They do not dry as well as in the stook, and when hauled should be put into rather narrow and thoroughly ventilated cribs. The stalks as cut into the silo had the composition shown below. For comparison I give the average as stated by Jenkins and Winton.

Stalks, Longfellow corn, at glazing period: dry matter, 27.4 per cent.
Average flint corn fodder, glazed: dry matter, 22.9 per cent.

Composition of Dry Matter.

	Protein (Per Cent.).	Crude Fat (Per Cent.).	Cellulose (Per Cent.).	Nitrogen-free Extract (Per Cent.).
Longfellow corn stalks, . .	9.33	1.29	29.53	57.64
Average flint corn fodder (glazed),	9.20	3.70	18.90	63.20

It will be seen that these stalks compare very favorably with average corn fodder in composition. This would appear to be, then, a good method of utilizing a corn crop, as there can be no doubt that such stalks will make good silage, and in this form they will all be eaten, while if dried in the ordinary way there is almost inevitably considerable waste.

Live Stock.

Horses. — There has been no sickness among our horses during the year, and we now have the following animals: Percherons: 1 stallion, 1 mare, 2 stallion colts; 1 three-fourths Percheron mare, 3 three-fourths Percheron colts; French coach: 1 stallion colt and 1 mare colt; 2 mares and 2 geldings; total, 14.

Cattle. — Since my last report another car load of heifers has been purchased in South Dakota. These are nearly all grade Shorthorns, like the cows and heifers purchased there last year. Some of the less desirable for dairy purposes of both importations will be fattened. We propose to retain sixty head as a foundation upon which to build up a dairy herd by crosses with bulls of the dairy breeds. The animals put into our barn last year have shown every indication of perfect health throughout the year. They are rugged and hearty, and among those which have calved are found a fair share of good milkers. The average yield is far less than with our old herd, but this is only what was anticipated. We looked for constitution as a basis for a profitable dairy herd and believe we have got it.

For crossing with the Dakota cattle and for educational purposes we have put into our barns pure-bred animals, beginning with one male and one female of each, of the following breeds: Shorthorn, Guernsey, Jersey, Ayrshire, Holstein-Friesian and Aberdeen-Angus. These animals were tuberculin tested before purchase, and have all appeared perfectly healthy since we obtained them. They have all been re-tested this fall, and, showing no indications of tuberculosis, have (with the exception of the Jerseys) been put into the new barn. The Jerseys were received later than the others, and will be kept in quarantine somewhat longer.

Of neat cattle we now own as follows: Shorthorns: 1 bull, 1 cow, 1 heifer; Guernseys: 2 bulls, 1 cow; Jerseys, 1 bull, 1 heifer; Ayrshires: 1 bull, 1 heifer; Holstein-Friesian: 1 bull, 1 cow, 1 heifer; Aberdeen-Angus: 1 bull, 1 cow, 1 heifer; Dakota animals: 26 cows, 52 heifers; grade Hereford: 1 heifer; total, 95.

Sheep. — Our flock has suffered from two attacks by dogs during the year, the total number of animals lost being nine. It is true that we receive payment for animals killed; but as these are often among the choicest of the flock (true in this case), and those left are seriously injured by the fright, the damage is serious and the discouragement great. The dog law should be modified so that sheep husbandry may not become entirely a lost art among us.

Our flock now includes the following animals, all pure-bred Southdowns: 1 ram, 26 breeding ewes, 3 ram lambs, 8 ewe lambs; total, 38.

Swine. — Our swine have but recently been purchased. We have excellent animals (one male and one female) of each of the following breeds: Berkshire, Tamworth, Cheshire, Poland-China and Chester-White; total, 10.

From what has been written, it will be seen that our facilities for instruction in matters pertaining to live stock are much more

extensive than ever before. I desire that it shall be recognized that our stock has been selected with reference largely to educational value, and not with a view to profit.

Farm Receipts.

The total receipts of the year for products sold and for labor performed for other departments by farm teams and men amount to a little more than $8,000. The leading items contributing to this total are the following: hay, $889.27; potatoes, $1,378.73; dairy products, $750.27; beef, $303.16; sheep, lambs and wool, $413.35; corn, $581.71; wood and lumber, $2,264; and work, $517.49.

Permanent Improvements.

The work of improvement has been prosecuted as opportunity presented itself. The most important items for the year are the following: —

The breaking up and clearing of the two-acre stump lot just south of our barns has been completed; a very good crop of corn for the silo was raised thereon, and the lot is now seeded to grass.

One hundred and twenty-five rods of new farm road, including one substantial stone culvert, have been built. The cellars of the old barn and farm-house have been filled, and the surroundings graded and fitted for cultivation. The fence surrounding the old paddock has been taken up and reset for the new inclosure. Substantially constructed yards connected with our piggery have been built.

The grounds about the farm-house in its new location have been graded and seeded, and planted with ornamental trees and shrubs. The site of the old horse shed and pine grove and the old drives about them have been cleared, graded and seeded.

The most important and extensive work has been that done in clearing and burning, harrowing and seeding the wood lot south of the Plainfield road. The brush on about twenty-seven acres has been cut, the lot burned over, the remnants of branches, etc., piled and burned, the ground between the stumps harrowed, and all sown with a mixture of grass and clover seeds. These made a good start, and the lot, for which we now have purchased the necessary fencing materials, will furnish a great deal of pasturage another season.

It has been found necessary to repaint the steel roofs of our new buildings. Upon the recommendation of the contractors doing the work, the roofs were first painted with a graphite paint made by the Dixon Crucible Company. This was an ex-

pensive paint, and it was expected that it would prove considerably more durable than the ordinary iron oxide paints. This expectation was disappointed. The roofs began to rust within a very few months after they were painted, and soon got into very bad condition. They have now been rubbed with a steel brush where badly rusted, and all covered with two coats of boiled linseed oil and iron oxide paint. This has necessitated an expenditure of $267, of which sum the company that originally did the work furnished $40. The roofs now appear to be in fine condition, and it is hoped they will need no further attention for several years.

Conclusion.

The plant food account, which is kept with our several fields, shows that the soil in almost all, as a result of the operations of the past year, has been considerably enriched in phosphates and potash; while, since clover finds an important place in all our mowings, it is believed that we have added to the store of nitrogen which will become available for future crops. It is confidently anticipated, therefore, that, with the large amount of manure we are now making, the crops of another season will be larger than ever before, — and that with a smaller expenditure for fertilizers.

Our fields will more and more largely be used in such a manner as to serve educational purposes and to throw light upon some of the many problems in the great field of agriculture. I believe, with Professor Sanborn, in *extensive* intensive farming, in the larger use of machinery and labor-saving methods; and, as our land is gradually still further cleared, drained, graded and laid out, we hope to illustrate such methods in a worthy manner.

Some of the Western correspondents of the agricultural papers claim to be able to produce potatoes at from five to twelve cents per bushel. We are fortunately so protected by freight rates that we are not obliged to meet these men on equal terms; but, on the other hand, we must incur an expenditure for fertilizers from which these Western farmers are at present exempt. The actual plant food (nitrogen, phosphate and potash) contained in one hundred bushels of potatoes can at the present time be purchased for less than five dollars. It is true that we must apply more to get the one hundred bushels; but it is possible to so manage as to recover most of the surplus in future crops, and it should be possible also to draw some of the required nitrogen from the air by means of the clover "nitrogen traps." The actual fertilizer cost of potatoes can, I believe, be kept as low as five cents per

bushel, and, since freight from most of the great centres of potato production is more than this figure, it should be possible for our farmers to successfully compete in the production of this crop; but they can do this only by adopting the labor-saving methods of their competitors. Such methods are possible only with large and well-cleared fields, and these methods we can illustrate here, — by the use of the sulky or gang plough, the potato planter, Breed's weeder, the potato digger, Leggett's Paris Green gun, etc. The cost of labor and seed this year with our poor crop was less than nineteen cents per bushel. Had our seed all been good and the entire field well suited for the crop, the labor cost would undoubtedly have been only about twelve cents per bushel. Last year, on our best field, 4.6 acres, the labor cost of the crop stored in the cellar was but little more than thirteen cents per bushel.

The potato is but one of the many crops with which such illustrations can be and are given here; and it is hoped that along this line the farm is entering upon an enlarged field of usefulness to the farming public as well as to our students.

I desire, finally, to testify to continued faithful and interested work on the part of superintendent, foreman and laborers, as well as to cordial support and encouragement from superiors. To all I tender my sincere thanks.

William P. Brooks,
Professor of Agriculture and Director of the Farm.

Amherst, Dec. 26, 1895.

GIFTS.

From Sir John B. Lawes of Rothamsted, Eng., "Rothamsted experiments over fifty years;" "Feeding of animals;" "Rotation of crops."

Prof. H. B. Adams of Baltimore, Md., picture of Lord Amherst; "Maryland's influence in founding a national commonwealth."

The military instructors stationed at the college, picture of Napoleon.

E. B. Bragg (M. A. C., '75) of Cleveland, O., collection of birds' eggs.

Joseph E. Pond, Esq., of North Attleborough, six volumes "Bee Journals."

J. S. Sanborn of Poland, Me., seven engravings of French coach horses.

From J. A. Harwood of Littleton, two portraits belted Dutch cattle; one set "Herd Books," belted Dutch cattle.

J. M. Thorburn & Co. of New York, seeds of new fodder plant.

J. M. Sears of Boston, Jersey bull and heifer.

Genesee Salt Company of Genesee, N. Y., samples dairy and table salt.

Gregory & Son of Marblehead, several varieties millet seed.

Joseph Breck & Sons of Boston, one variety potato.

H. D. Fearing of Amherst, one variety potato.

E. Hickok of Rose, N. Y., one variety potato.

J. Wiley & Sons of New York, "Agricultural calendar for 1895."

Massachusetts Society for Promoting Agriculture, "Infectiousness of milk."

Mrs. W. S. Clark of Newton, Balch's "Mines, miners and mining interests of the United States."

American Humane Education Society, "Vivisection."

College Reading Room Association, four volumes magazines.

Miss Eleanor A. Ormerod of Spring Grove, Eng., "Report of observations of injurious insects, 1894."

Carl Freigau of Dayton, O., "Ohio Poland-China Record."

W. H. Caldwell (M. A. C., '87) of Peterboro, N. H., sixth volume "Guernsey Herd Register."

Hon. George F. Hoar of Washington, D. C., one hundred and thirty-three volumes government publications.

Hon. Henry C. Lodge of Washington, D. C., twenty-five volumes government publications.

Ginn & Co. of Boston, "Book of Elizabethan lyrics."

Board of Agriculture, England, "Report of experiments with potatoes and onions."

J. B. Lindsey (M. A. C., '83) of Amherst, "Creamery practice;" "Darmstadt Agricultural Experiment Station."

I. C. Greene (M. A. C., '94) of Fitchburg, "American crow."

Hon. John E. Russell of Leicester, thirty-one copies "The Monroe Doctrine."

Indian Rights Association, annual reports of executive committee, 2–12.

American-Angus Breeding Association, six volumes "Herd Book."

Bureau of American Republics, nineteen volumes.

From A. H. Winchell of Minneapolis, Minn., two volumes "Geological survey of Minnesota."

Holstein-Friesian Association, thirteenth volume "Herd Book."

Mrs. H. J. Clark of Amherst, Clark's "Lucernariæ."

Sander's Publishing Company of Chicago, Ill., Plumb's "Indian Corn."

In addition to the customary reports from the treasurer and the military department, I have the honor, in conformity to the law requiring the college in its annual report to publish such information as may be useful to the community, to append the annual report of the experiment department of the college, and an illustrated monograph by Prof. Charles H. Fernald on the "Crambidæ," a class of insects peculiarly destructive.

Respectfully submitted, by order of the trustees,

HENRY H. GOODELL,
President.

Jan. 1, 1896.

TREASURER'S REPORT.

Report of George F. Mills, *Treasurer pro tem. of Massachusetts Agricultural College, from Jan. 1, 1895, to Jan. 1, 1896.*

	Received.	Paid.
Cash on hand Jan. 1, 1895,	$853 13	–
Morrill fund,	1,000 00	–
Term bill,	4,569 21	$956 32
Horticultural department,	5,454 78	7,491 68
Farm,	8,324 77	12,293 39
Expense,	1,223 63	8,365 17
Salary,	701 05	13,772 27
Endowment fund,	11,082 16	–
State scholarship fund,	15,000 00	–
Chemical laboratory,	1,098 26	776 49
Botanical laboratory,	93 50	98 95
Entomological laboratory,	48 00	68 06
Zoölogical laboratory,	96 00	75 57
Labor fund,	5,379 71	5,117 72
Gassett scholarship fund,	85 88	147 50
Whiting Street fund,	62 30	60 85
Grinnell prize fund,	42 50	60 00
Mary Robinson fund,	35 84	60 00
Burnham emergency fund,	200 00	80 00
Hills fund,	356 16	459 93
Extra instruction,	–	612 50
Advertising,	–	635 30
Library fund,	565 02	565 02
Investment, N. Y. C. & H. R. R.R. stock,	4 25	–
Insurance,	89 35	649 12
Insurance, barn,	48 70	898 55
Insurance, vehicles, tools, etc.,	37 25	616 26
Electric plant,	441 24	2,976 22
Cash on hand Jan. 1, 1896,	–	55 82
	$56,892 69	$56,892 69

This is to certify that I have this day examined the accounts of George F. Mills, treasurer *pro tem.* of the Massachusetts Agricultural College, from Jan. 1, 1895, to Jan. 1, 1896, and find the same correct, properly kept, and all disbursements vouched for, the balance in the treasury being fifty-five and eighty-two one-hundredths dollars ($55.82), which sum is shown to be in the hands of the treasurer.

CHARLES A. GLEASON, *Auditor.*

Amherst, Dec. 27, 1895.

Cash Balance, as shown by the Treasurer's Statement, belongs to the Following Accounts:

Burnham emergency fund,	$55 82

Bills receivable Jan. 1, 1896.

Term bill,	$1,080 74
Horticultural department,	228 55
Farm,	578 65
Expense,	149 26
Electric plant,	184 51
Chemical laboratory,	341 82
Botanical laboratory,	10 00
Zoölogical laboratory,	56 00
Entomological laboratory,	8 00
	$2,637 53

Bills payable Jan. 1, 1896.

Horticultural department,	$359 26
Farm,	3,505 70
Electric plant,	275 53
Expense,	279 06
Chemical laboratory,	74 93
Labor fund,	404 44
Insurance, barn,	2,509 16
Insurance, vehicles, tools, etc.,	101 70
Gassett scholarship fund,	26 02
Whiting Street fund,	67 51
Grinnell prize fund,	20 00
Mary Robinson fund,	13 08
Burnham emergency fund,	303 48
Hills fund,	43 73
Morrill fund,	1,000 00
	$8,983 60

Inventory — real estate.

Land.

	Cost.	
College farm,	$37,000 00	
Pelham quarry,	500 00	
Bangs place (with house, shed and barn),	2,525 00	
		$40,025 00

Buildings.

	Cost.	
Drill hall,	$6,500 00	
Powder house,	75 00	
Gun shed,	1,600 00	
Stone chapel,	31,000 00	
Amounts carried forward,	$39,175 00	$40,025 00

Amounts brought forward,	$39,175 00	$40,025 00
South dormitory,	37,000 00	
North dormitory,	36,000 00	
Chemical laboratory,	10,360 00	
Entomological laboratory,	3,000 00	
Farm-house,	4,000 00	
Horse barn,	5,000 00	
Farm barn and dairy school,	33,000 00	
Graves house and barn,	8,000 00	
Boarding-house,	8,000 00	
Botanic museum,	5,180 00	
Botanic barn,	1,500 00	
Botanic barn addition,	1,000 00	
Tool house,	2,000 00	
Durfee plant house and fixtures,	12,000 00	
Small plant house, with vegetable cellar and cold grapery,	4,700 00	
President's house,	11,500 00	
Dwelling-house, purchased with farm,	7,500 00	
		228,915 00
		$268,940 00

PERSONAL PROPERTY.

Electric plant,	$8,700 00
New York Central & Hudson River Railroad stock,	100 00
Botanical department,	3,610 00
Horticultural department,	7,006 11
Farm,	15,903 70
Chemical laboratory,	2,149 00
Botanical laboratory,	2,056 53
Natural history collection,	4,758 79
Veterinary department,	1,443 39
Agricultural department,	2,675 00
Physics department,	5,471 28
Library,	17,080 00
Fire apparatus,	450 00
Furniture,	640 00
Books in treasurer's office,	297 82
	$72,341 62

SUMMARY.

Assets.

Total value of real estate, per inventory,	$268,940 00
Total value of personal property, per inventory,	72,341 62
Bills receivable, per inventory,	2,637 53
	$343,919 15

Liabilities.

Bills payable, per inventory,	$8,983 60
	$334,935 55

Maintenance Funds.

Technical educational fund, United States grant,	$219,000 00
Technical educational fund, State grant, . .	141,575 35
	$360,575 35

Two-thirds of the income from these funds is paid to the treasurer of the college and one-third to the Institute of Technology. Amount received by the college treasurer from Jan. 1, 1895, to Jan. 1, 1896, ...	$11,082 16
Hills fund, the gift of Messrs. L. M. and H. F. Hills of Amherst, now amounts to $8,542. By conditions of the gift the income is to be used for the maintenance of a botanic garden. Income from Jan. 1, 1895, to Jan. 1, 1896, . .	356 16
Annual State appropriation, $10,000. This sum was appropriated for four years by the Legislature of 1889, and continued for another four years by the Legislature of 1892, for the endowment of additional chairs of instruction and for general expense. Five thousand dollars of this sum was set apart as a labor fund, to be used in payment of labor performed by needy and worthy students. Amount received from annual State appropriation for college expense from Jan. 1, 1895, to Jan. 1, 1896, ...	5,000 00
Amount received as labor fund, ...	5,000 00

Scholarship Funds.

State scholarship fund, $10,000. This sum was appropriated by the Legislature in 1886, and is paid to the college treasurer in quarterly payments. Amount received from Jan. 1, 1895, to Jan. 1, 1896, ...	10,000 00
Whiting Street fund, $1,000. This fund is a bequest without conditions. To it was added, by vote of the trustees in January, 1887, the interest accrued on the bequest, $260. Amount of the fund, Jan. 1, 1896, $1,260. Income from Jan. 1, 1895, to Jan. 1, 1896, ...	62 30
Gassett scholarship fund, $1,000. This sum was given by Hon. Henry Gassett as a scholarship. Income from Jan. 1, 1895, to Jan. 1, 1896, ...	85 88
Mary Robinson fund, $858. This fund was given without conditions. The income from it has been appropriated for scholarships to worthy and needy students. Income from Jan. 1, 1895, to Jan. 1, 1896, ...	35 84
Amount carried forward, ...	$31,622 34

Amount brought forward, ...	$31,622 34

Prize Funds.

Grinnell prize fund, $1,000. This fund is the gift of ex-Gov. William Claflin, and is called Grinnell fund, in honor of his friend. The income from it is appropriated for two prizes, to be given to the two members of the graduating class who pass the best examination in agriculture. Income from Jan. 1, 1895, to Jan. 1, 1896, ...	42 50

Miscellaneous Funds.

Library fund, for the benefit of the library. Amount of fund, Dec. 31, 1895, $9,420.47.	
Burnham emergency fund, $5,000. This fund is a bequest of Mr. T. O. H. P. Burnham, late of Boston, and was made without conditions. The trustees have voted that this fund be kept intact, and that the income from it be used by the trustees for such purposes as they believe to be for the best interests of the college. Income from Jan. 1, 1895, to Jan. 1, 1896, ...	200 00
Income from Jan. 1, 1895, to Jan. 1, 1896, ...	$31,864 84

To this sum must be added amount of tuition and room rent, and receipts from sales from farm and from botanic gardens. These amounts can be learned from treasurer's statement, tuition, laboratory taxes and room rent being included in term bill account.

REPORT OF THE PRESIDENT OF THE MASSACHUSETTS AGRICULTURAL COLLEGE TO THE SECRETARY OF AGRICULTURE AND THE SECRETARY OF THE INTERIOR, AS REQUIRED BY ACT OF CONGRESS OF AUG. 30, 1890, IN AID OF COLLEGES OF AGRICULTURE AND THE MECHANIC ARTS.

I. Condition and Progress of the Institution, Year ended June 30, 1895.

The hard times seriously affected the prosperity of the college during the year ending June 30, 1895, although the total attendance was but slightly less than that of the preceding year. An assistant in the chair of botany has increased the teaching force to nineteen. The most important changes have been the separation of the chairs of horticulture and botany, previously united under one head, and the consolidation of the State Experiment Station with that established by the federal government, under the name of the Hatch Experiment Station of the Massachusetts Agricultural College, the two together forming the experiment department of the college. This has been with a view to securing economy of work and uniformity of result, and to simplifying questions of administration. Under this new departure, the president of the college becomes director of the station.

An instructive course of lectures on "Civil Polity" was given to the college during the year by Mr. R. L. Bridgman of Boston, and a series of lectures by various scientific authorities was planned and carried out under the auspices of the Natural History Society.

Under appropriation from the State, a building to be used as a laboratory has been commenced, for the benefit of those receiving instruction in economic entomology; a gun shed with practice gallery has been erected, and important additions have been made to the library.

II. Receipts for and during the Year ended June 30, 1895.

1. Balance on hand July 1, 1894,	$167 01
2. State aid: (*a*) Income from endowment,	3,637 07
(*b*) Appropriations for building or other special purposes,	15,000 00
(*c*) Appropriations for current expenses,	10,000 00
3. Federal aid: (*a*) Income from land grant, act of July 2, 1862,	7,300 00
(*b*) For experiment stations, act of March 2, 1887,	15,000 00
(*c*) Additional endowment, act of Aug. 30, 1890,	13,333 33
4. Fees and all other sources,	560 00
Total receipts,	$64,997 41

III. Expenditures for and during the Year ended June 30, 1895.

1.	College of Agriculture and Mechanic Arts,	$49,997 41
2.	Experiment Station,	15,000 00
	Total expenditures,	$64,997 41

IV. Property and Equipment, Year ended June 30, 1895.

Agricultural department: —	
Value of buildings,	$264,340 00
Value of other equipment,	$67,188 67
Total number of acres,	384
Acres under cultivation,	250
Acres used for experiments,	60
Value of farm lands,	$41,000 00
Amount of all endowment funds,	$360,575 35

V. Faculty during the Year ended June 30, 1895.

		Male.	Female.
1.	College of Agriculture and Mechanic Arts, collegiate and special classes,	19	–
2.	Number of staff of Experiment Station,	18	1
	Total, counting none twice,	29	1

VI. Students during the Year ended June 30, 1895.

1.	College of Agriculture and Mechanic Arts, collegiate and special classes,	192
2.	Graduate courses,	14
	Total, counting none twice,	206

VII. Library, Year ended June 30, 1895.

1.	Number of bound volumes June 30, 1894,	*15,440
2.	Bound volumes added during year ended June 30, 1895,	*943
	Total bound volumes,	16,383

* Pamphlets, none.

MILITARY DEPARTMENT.

AMHERST, MASS., Dec. 31, 1895.

To President H. H. GOODELL,
Massachusetts Agricultural College.

SIR: — I have the honor to submit the following report of the military department of the college for the year ending Dec. 31, 1895.

During the past year the military equipment has been increased by two 3.2-inch breech-loading steel guns; these are the same as those used in the United States Army, and represent the principles governing the construction of all field artillery used at the present day. Facilities for military instruction have been further increased, by the construction of a balcony across the south end of the drill hall, and a gun shed, twenty-eight by sixty feet, west of the drill hall, with which it is connected by an enclosed passageway. This gun shed is now used as a place of storage for the field guns. On its west side a shooting gallery has been built, where during the winter months the members of the lower classes will receive instruction in the principles of target practice, such instruction being of great importance before they are sent to the target range during the summer term. The gun shed is of a size sufficiently large to permit of its being used as the armory; the only changes necessary would be the ceiling of the shed, to make it warmer, and the transferring of the gun racks now in the armory. The present armory room could then be used as a lavatory, shower baths especially being much needed in connection with the gymnasium, which is in the drill hall. The outside of the drill hall requires painting, in places the paint having commenced to peel off; otherwise the entire building is in excellent repair.

The instruction in this department has been, as in previous years, both practical and theoretical.

Practical. — The battalion is at present organized with three companies and a band; the instruction has been in the "school of

the soldier," "school of the company," "school of the battalion," and "extended order;" during the winter term the junior class received instruction in "sabre drill," and during the fall term the sophomore and second-year classes in "bayonet exercise" and artillery. All members of the battalion are required to attend target practice, details being sent each drill day, when the weather permits, under a cadet lieutenant, to the target range for that purpose. The total number of shots fired during the last college year was 2,645, 123 students participating in this practice; the arm used was the Springfield cadet rifle. Certain members of the senior class have received instruction in signalling, both with the flag and heliograph.

Theoretical. — This instruction has consisted of recitations in the "Infantry Drill Regulations," by the senior, freshman and first-year classes, and of lectures given to the senior class on military law, explosives, fortifications, art and science of war, army administration and other kindred subjects. I consider this instruction of great importance, especially to members of the senior class who are of sufficient age to appreciate it, and who are thus enabled to obtain some slight knowledge of a subject seldom understood by civilians, and which may become of great importance to them in future years.

It has been my aim, during my tour of duty here, to impress on the students the necessity of discipline, and I have been much pleased at the manner in which my efforts have been rewarded. All students of the college, except post-graduates, are required to attend drill, except those excused by the surgeon on account of physical disability; there are three drills each week, of one hour. The total number of students receiving military instruction at the present time is 101.

A gold medal was given last winter by Mr. I. C. Greene of Fitchburg as a prize to the student best drilled in the "Manual of Arms." This medal was won by Cadet C. A. Norton of Lynn, a member of the present junior class; the judge was Capt. J. S. Pettit, United States Army, at present military instructor at Yale University.

The following three members of the last graduating class were reported to the Adjutant-General of the Army and to the Adjutant-General of the State of Massachusetts as having shown the greatest proficiency in the art and science of war: —

Henry A. Ballou,	*West Fitchburg, Mass.*
Edile H. Clark,	*Spencer, Mass.*
Robert S. Jones,	*Dover, Mass.*

The following is a list of the United States government property now on hand: —

Ordnance.

2 3.2-inch breech-loading steel guns.
2 8-inch mortars, with implements.
2 gun carriages.
2 gun caissons, with spare wheels.
2 mortar beds.
147 Springfield cadet rifles.
147 infantry accoutrements, sets.
51 headless shell extractors.
100 blank cartridges for field guns.
4,000 metallic ball cartridges.
3,000 metallic blank cartridges.
350 friction primers.
2 mortar platforms.
6,000 pasters.
100 targets, paper.
35,000 cartridge primers.
25,000 round balls.
1 hand reloading tools, set.
100 small-arms powder, pounds.
2 implements and equipments for 3.2-inch breech-loading steel guns, sets.

Signal.

2 heliographs, complete.
6 2-foot white flags.
6 2-foot red flags.
6 canvas cases and straps.
12 joints of staff.

The battalion organization is as follows: —

Commandant.

Lieut. W. M. Dickinson, ... U. S. Army.

Commissioned Staff.

Cadet First Lieutenant and Adjutant, . . F. E. DeLuce.
Cadet First Lieutenant and Quartermaster, . N. Shultis.
Cadet First Lieutenant and Fire Marshal, . . F. H. Read.
Cadet First Lieutenant and Assistant Instructor of Musketry, ... R. P. Nichols.
Cadet First Lieutenant and Assistant Instructor in Signalling, ... J. L. Marshall.

Non-Commissioned Staff.

Cadet Sergeant-Major, ... G. D. Leavens.
Cadet Quartermaster-Sergeant, ... J. L. Bartlett.

Color Guard.

Cadet Color Sergeant, ... J. A. EMRICH.
Cadet Color Corporal, ... C. A. NORTON.
Cadet Color Corporal, ... C. A. PETERS.

Band.

Cadet First Lieutenant and Band Leader, Commanding Band, ... W. B. HARPER.
Cadet First Sergeant and Drum Major, . . C. I. GOESSMANN.
Cadet Band Corporal, ... F. W. BARCLAY.

Companies.

Cadet Capt. P. A. LEAMY, ... assigned to Company A.
Cadet Capt. I. C. POOLE, ... assigned to Company C.
Cadet Capt. H. C. BURRINGTON, . . assigned to Company B.
Cadet First Lieut. A. S. KINNEY, . . assigned to Company A.
Cadet First Lieut. H. T. EDWARDS, . . assigned to Company B.
Cadet First Lieut. F. B. SHAW, . . . assigned to Company C.
Cadet Second Lieut. E. W. POOLE, . . assigned to Company A.
Cadet Second Lieut. W. L. PENTECOST, . assigned to Company B.
Cadet Second Lieut. F. L. CLAPP, . . assigned to Company C.
Cadet First Sergeant C. A. KING, . . assigned to Company A.
Cadet First Sergeant J. M. BARRY, . . assigned to Company B.
Cadet First Sergeant H. J. ARMSTRONG, . assigned to Company C.
Cadet Sergeant P. H. SMITH, Jr., . . assigned to Company B.
Cadet Sergeant H. F. ALLEN, . . . assigned to Company B.
Cadet Sergeant G. A. DREW, . . . assigned to Company A.
Cadet Sergeant J. W. ALLEN, . . . assigned to Company A.
Cadet Sergeant L. F. CLARK, . . . assigned to Company C.
Cadet Sergeant M. E. COOK, . . . assigned to Company C.
Cadet Corporal C. F. PALMER, . . . assigned to Company B.
Cadet Corporal L. L. CHENEY, . . . assigned to Company A.
Cadet Corporal A. MONTGOMERY, Jr., . assigned to Company C.
Cadet Corporal R. D. WARDEN, . . . assigned to Company A.
Cadet Corporal J. P. NICKERSON, . . assigned to Company A.
Cadet Corporal G. H. WRIGHT, . . . assigned to Company C.

Arrangements have recently been made for a competitive individual drill, preceded by a review, to take place in Mechanics Hall, Boston, on the evening of May 15, 1896, the participants being students from the Massachusetts Institute of Technology, Harvard University, Brown University and this college. I desire to take about twenty-seven of the cadets from our battalion to Boston on that day.

Respectfully submitted,

W. M. DICKINSON,
Lieutenant United States Army.

CALENDAR FOR 1896–97.

1896.

January 2, Thursday, winter term begins, at 8 A.M.

March 19, Thursday, winter term closes, at 10.15 A.M.

April 2, Thursday, spring term begins, at 8 A.M.

June 13, Saturday, Grinnell prize examination of the senior class in agriculture.

June 14, Sunday, { Baccalaureate sermon. Address before the College Young Men's Christian Association.

June 15, Monday, { Burnham prize speaking. Meeting of the alumni. Flint prize oratorical contest.

June 16, Tuesday, { Class-day exercises. Military exercises. Reception by the president and trustees.

June 17, Wednesday, Commencement exercises.

June 18–19, Thursday and Friday, examinations for admission, at 9 A.M., Botanic Museum, Amherst; at Jacob Sleeper Hall, Boston University, 12 Somerset Street, Boston; and at Sedgwick Institute, Great Barrington. Two full days are required for examination, and candidates must come prepared to stay that length of time.

September 1–2, Tuesday and Wednesday, examinations for admission, at 9 A.M., Botanic Museum.

September 3, Thursday, fall term begins, at 8 A.M.

December 23, Wednesday, fall term closes, at 10.15 A.M.

1897.

January 6, Wednesday, winter term begins, at 8 A.M.

March 25, Thursday, winter term closes, at 10.15 A.M.

THE CORPORATION.

	Term expires.
HENRY S. HYDE of Springfield,	1897
MERRITT I. WHEELER of Great Barrington,	1897
JAMES S. GRINNELL of Greenfield,	1898
JOSEPH A. HARWOOD of Littleton,	1898
WILLIAM H. BOWKER of Boston,	1899
J. D. W. FRENCH of Boston,	1899
J. HOWE DEMOND of Northampton,	1900
ELMER D. HOWE of Marlborough,	1900
FRANCIS H. APPLETON of Lynnfield,	1901
WILLIAM WHEELER of Concord,	1901
ELIJAH W. WOOD of West Newton,	1902
CHARLES A. GLEASON of New Braintree,	1902
JAMES DRAPER of Worcester,	1903
SAMUEL C. DAMON of Lancaster,	1903

Members Ex Officio.

His Excellency Governor FREDERIC T. GREENHALGE,
President of the Corporation.

HENRY H. GOODELL, *President of the College.*

FRANK A. HILL, *Secretary of the Board of Education.*

WILLIAM R. SESSIONS, *Secretary of the Board of Agriculture.*

JAMES S. GRINNELL of Greenfield,
Vice-President of the Corporation.

WILLIAM R. SESSIONS of Hampden, *Secretary.*

GEORGE F. MILLS of Amherst, *Treasurer pro tempore.*

CHARLES A. GLEASON of New Braintree, *Auditor.*

Committee on Finance and Buildings.*

JAMES S. GRINNELL. HENRY S. HYDE.
J. HOWE DEMOND. SAMUEL C. DAMON.
CHARLES A. GLEASON, *Chairman.*

Committee on Course of Study and Faculty.*

WILLIAM H. BOWKER. ELMER D. HOWE.
FRANCIS H. APPLETON. J. D. W. FRENCH.
WILLIAM WHEELER, *Chairman.*

Committee on Farm and Horticultural Departments.*

ELIJAH W. WOOD. JAMES DRAPER.
JOSEPH A. HARWOOD. MERRITT I. WHEELER.
WILLIAM R. SESSIONS, *Chairman.*

Committee on Experiment Department.*

CHARLES A. GLEASON. ELIJAH W. WOOD.
WILLIAM WHEELER. JAMES DRAPER.
WILLIAM R. SESSIONS, *Chairman.*

Board of Overseers.

STATE BOARD OF AGRICULTURE.

Examining Committee of Overseers.

A. C. VARNUM (*Chairman*), . of Lowell.
GEORGE CRUIKSHANKS, . . of Fitchburg.
E. A. HARWOOD, . . . of North Brookfield.
JOHN BURSLEY, ... of Barnstable.
A. D. RAYMOND, . . . of Royalston.

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* The president of the college is ex-officio a member of each of the above committees.

The Faculty.

HENRY H. GOODELL, LL.D., *President*,
Professor of Modern Languages.

LEVI STOCKBRIDGE,
Professor of Agriculture, Honorary.

CHARLES A. GOESSMANN, Ph.D., LL.D.,
Professor of Chemistry.

SAMUEL T. MAYNARD, B.Sc.,
Professor of Horticulture.

CHARLES WELLINGTON, Ph.D.,
Associate Professor of Chemistry.

CHARLES H. FERNALD, Ph.D.,
Professor of Zoölogy.

Rev. CHARLES S. WALKER, Ph.D.,
Professor of Mental and Political Science.

WILLIAM P. BROOKS, B.Sc.,
Professor of Agriculture.

GEORGE F. MILLS, M.A.,
Professor of English and Latin.

JAMES B. PAIGE, V.S.,*
Professor of Veterinary Science.

WALTER M. DICKINSON, 1st Lieut. 17th Infantry, U.S.A.,
Professor of Military Science and Tactics.

LEONARD METCALF, B.S.,
Professor of Mathematics and Civil Engineering.

GEORGE E. STONE, Ph.D.,
Professor of Botany.

HERMAN BABSON, B.A.,
Assistant Professor of English.

EDWARD R. FLINT, Ph.D.,
Assistant Professor of Chemistry.

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* On leave.

FRED S. COOLEY, B.Sc.,
Assistant Professor of Agriculture and Farm Superintendent.

RICHARD S. LULL, B.S.,
Assistant Professor of Zoölogy.

RALPH E. SMITH, B.Sc.,
Instructor in German and Botany.

PHILIP B. HASBROUCK, B.S.,
Assistant Professor of Mathematics.

EUGENE H. LEHNERT, V.S.,
Instructor in Veterinary Science.

ROBERT W. LYMAN, LL.D.,
Lecturer on Farm Law.

HENRY H. GOODELL, LL.D.,
Librarian.

Graduates of 1895.*

Ballou, Henry Arthur, . .	West Fitchburg.
Bemis, Waldo Louis, . .	Spencer.
Billings, George Austin (Boston Univ.), ...	South Deerfield.
Brown, William Clay (Boston Univ.), ...	Peabody.
Burgess, Albert Franklin (Boston Univ.), ...	Rockland.
Clark, Harry Edward (Boston Univ.), ...	Wilbraham.
Cooley, Robert Allen (Boston Univ.), ...	South Deerfield.
Crehore, Charles Winfred (Boston Univ.), ...	Chicopee.
Dickinson, Charles Morrison (Boston Univ.), . . .	Chicago, Ill.
Fairbanks, Herbert Stockwell (Boston Univ.), . . .	Amherst.

* The annual report, being made in January, necessarily includes parts of two academic years, and the catalogue bears the names of such students as have been connected with the college during any portion of the year 1895.

Foley, Thomas Patrick (Boston Univ.), ...	Natick.
Frost, Harold Locke (Boston Univ.), ...	Arlington.
Hemenway, Herbert Daniel (Boston Univ.), ...	Williamsville.
Jones, Robert Sharp (Boston Univ.), ...	Dover.
Kuroda, Shiro (Boston Univ.), .	Yamanouchi, Kitamura, Japan.
Lane, Clarence Bronson (Boston Univ.), ...	Killingworth, Conn.
Marsh, Jasper, ...	Danvers Centre.
Morse, Walter Levi (Boston Univ.), ...	Middleborough.
Potter, Daniel Charles (Boston Univ.), ...	Fairhaven.
Read, Henry Blood (Boston Univ.), ...	Westford.
Root, Wright Asahel (Boston Univ.), ...	Deerfield.
Smith, Arthur Bell (Boston Univ.), ...	North Hadley.
Stevens, Clarence Lindon, . .	Sheffield.
Sullivan, Maurice John (Boston Univ.), ...	Amherst.
Tobey, Frederick Clinton (Boston Univ.), ...	West Stockbridge.
Toole, Stephen Peter, . .	Amherst.
Warren, Franklin Lafayette (Boston Univ.), ...	Shirley.
White, Edward Albert (Boston Univ.), ...	Ashby.

Total, ... 28

Senior Class.

Burrington, Horace Clifton, .	Charlemont.
Clapp, Frank Lemuel, . .	Dorchester.
Cook, Allen Bradford, . .	Petersham.
DeLuce, Frank Edmund, . .	Warren.
Edwards, Harry Taylor, . .	Chesterfield.
Fletcher, Stephen Whitcomb, .	Rock.

Hammar, James Fabens, . .	Swampscott.
Harper, Walter Benjamin, . .	Wakefield.
Jones, Benjamin Kent, . .	Middlefield.
Kinney, Asa Stephen, . .	Worcester.
Kramer, Albin Maximilian, .	Clinton.
Leamy, Patrick Arthur, . .	Petersham.
Marshall, James Laird, . .	South Lancaster.
Moore, Henry Ward, . . .	Worcester.
Nichols, Robert Parker, . .	West Norwell.
Nutting, Charles Allen, . .	North Leominster.
Pentecost, William Lewis, . .	Worcester.
Poole, Erford Wilson, . .	North Dartmouth.
Poole, Isaac Chester, . . .	North Dartmouth.
Rawson, Herbert Warren, . .	Arlington.
Read, Frederick Henry, . .	Wilbraham.
Roper, Harry Howard, . .	East Hubbardston.
Saito, Seijiro, ...	Nemuro, Japan.
Sastré de Verand, Salome, . .	Tabasco, Mexico.
Sellew, Merle Edgar, . . .	East Longmeadow.
Shaw, Frederic Bridgman, . .	South Amherst.
Shepard, Lucius Jerry, . .	Oakdale.
Shultis, Newton, . . .	Medford.
Tsuda, George, ...	Tokyo, Japan.
Washburn, Frank Porter, . .	North Perry, Me.
Total, ...	30

Junior Class.

Allen, Harry Francis, . .	Northborough.
Allen, John William, . .	Northborough.
Armstrong, Herbert Julius, .	Sunderland.
Barclay, Frederick White, . .	Kent, Conn.
Barry, John Marshall, . .	Boston.
Bartlett, James Lowell, . .	Salisbury.
Cheney, Liberty Lyon, . .	Southbridge.
Clark, Lafayette Franklin, . .	West Brattleboro', Vt.
Cook, Maurice Elmer, . .	Shrewsbury.
Drew, George Albert, . .	Westford.
Eddy, John Richmond, . .	Boston.
Emrich, John Albert, . .	Amherst.
Goessmann, Charles Ignatius, .	Amherst.
Howe, Herbert Frank, . .	North Cambridge.
King, Charles Austin, . .	East Taunton.
Leavens, George Davison, . .	Brooklyn Heights, N. Y.

Millard, Frank Cowperthwait,	North Egremont.	
Norton, Charles Ayer,	Lynn.	
Palmer, Clayton Franklin,	Stockbridge.	
Peters, Charles Adams,	Worcester.	
Sherman, Carleton Farrar,	Jamaica Plain.	
Smith, Jr., Philip Henry,	South Hadley Falls.	
Walsh, Thomas Francis,	North Amherst.	
Total,		23

Sophomore Class.

Adjemian, Avedis Garrabet,	Kharpoot, Turkey.	
Baxter, Charles Newcomb,	Quincy.	
Charmbury, Thomas Herbert,	Amherst.	
Clark, Clifford Gay,	Sunderland.	
Eaton, Julian Stiles,	Nyack, N. Y.	
Fisher, Willis Sikes,	Ludlow.	
Kinsman, Willard Quincy,	Ipswich.	
Montgomery, Jr., Alexander,	Natick.	
Nickerson, John Peter,	West Harwich.	
Thompson, George Harris Austin,	Lancaster.	
Warden, Randall Duncan,	Roxbury.	
Wiley, Samuel William,	Amherst.	
Wolcott, Herbert Raymond,	Amherst.	
Wright, George Henry,	Deerfield.	
Total,		14

Freshman Class.

Armstrong, William Henry,	Cambridge.
Beaman, Dan Ashley,	Leverett.
Boutelle, Albert Arthur,	Leominster.
Chapin, William Edward,	Chicopee.
Chapman, John Chauncey,	Amherst.
Dana, Herbert Warner,	South Amherst.
Dickinson, Carl Clifton,	South Amherst.
Dutcher, John Remson,	Nyack, N. Y.
Gile, Alfred Dewing,	Worcester.
Hinds, Warren Elmer,	Townsend.
Holt, Henry Day,	Amherst.
Hooker, William Anson,	Amherst.
Hubbard, George Caleb,	Sunderland.
Keenan, George Francis,	Boston.
Maynard, Howard Eddy,	Amherst.

Pingree, Melvin Herbert, .	. Denmark, Me.
Smith, Samuel Eldredge, .	. Middlefield.
Turner, Frederick Harvey, .	. Housatonic.
Walker, Charles Morehouse,	. Amherst.
Wright, Edwin Monroe, .	. Manteno, Ill.
Total, ...	20

Graduates Two-Years Course.

Bagg, Elisha Aaron, . .	. West Springfield.
Delano, Charles Wesley, .	. North Duxbury.
Dutton, Arthur Edwin, .	. Chelmsford.
Hooker, William Anson, .	. Amherst.
Kinsman, Ernest Eugene, .	. Heath.
Rice, Benjamin Willard, .	. Northborough.
Sherman, Harry Robinson,	. Dartmouth.
Stearns, Harold Everett, .	. Conway.
Sweetser, Frank Eaton, .	. Danvers.
Tisdale, Fred Alvin, . .	. North Amherst.
Todd, Frederick Gage, .	. Dorchester.
Wentzell, William Benjamin,	. Amherst.
Total, ...	12

Second Year.

Alexander, Leon Rutherford,	. East Northfield.
Atkins, Harvey Robbins, .	. North Amherst.
Barrett, Frederick Eugene,	. Framingham.
Brainard, Everett Eugene, .	. Amherst.
Capen, Elwyn Winslow, .	. Stoughton.
Coleman, Robert Parker, .	. West Pittsfield.
Courtney, Howard Scholes,	. Attleborough.
Crook, Alfred Clifton, .	. Portland, Me.
Davis, John Alden, . .	. East Longmeadow.
Dickinson, Harry Porter, .	. Sunderland.
Eaton, Williams, . .	. North Middleborough.
Lincoln, Leon Emory, .	. Taunton.
Manzanilla, Lorenzo Montore,	. Merida, Yucatan, Mexico.
Pasell, George Walter, .	. New Bedford.
Roberts, Percy Colton, .	. North Amherst.
Rowe, Henry Simpson, .	. South Deerfield.
Stedman, Benjamin, . .	. Chicopee.
Tisdale, Charles Ernest, .	. North Amherst.
Total, ...	18

First Year.

Ashley, Henry Simeon,	East Longmeadow.
Blair, Claude Addison,	Amherst.
Burrington, John Cecil,	Charlemont.
Canto, José Dolores Boliver,	Cansahcat, Yucatan.
Canto, Ysidro Herrera,	Cansahcat, Yucatan.
Chapin, Warren Luther,	East Amherst.
Colburn, Charles Day,	Westford.
Dye, Willie Arius,	Sheffield.
Humphrey, Charles Leonard,	Amherst.
Isham, John Burt,	Hampden.
March, Allen Lucas,	Ashfield.
Merriman, Francis Evander,	Boston.
Pendleton, Charles Bemis,	Willimansett.
Perry, Edward King,	Brookline.
Sastré de Verand, César,	Tabasco, Mexico.
Sharpe, Edward Hewett,	Northfield.
Smith, Bernard Howard,	Middlefield.
Smith, Carl William,	Melrose.
Stacy, Clifford Eli,	Gloucester.
Total,	19

Graduate Course.

For Degree of M.S.

Carpenter, Malcolm Austin (B.Sc. 1891),	Leyden.
Kirkland, Archie Howard (B.Sc. 1894),	Norwich.
Smith, Frederic Jason (B.Sc. 1890),	North Hadley.
Total,	3

Resident Graduates at the College and Experiment Station.

Arnold, B Sc , Frank Luman (Boston Univ.),	Belchertown.
Crocker, B.Sc., Charles Stoughton (Boston Univ.),	Sunderland.
Haskins, B.Sc., Henri Darwin (Boston Univ.),	North Amherst.

Holland, B.Sc., Edward Bertram (Boston Univ.),	Amherst.
Johnson, B.Sc., Charles Henry (Boston Univ.),	Prescott.
Putnam, B.Sc., Joseph Harry (Boston Univ.),	West Sutton.
Shepardson, B.Sc., William Martin (Boston Univ.),	Warwick.
Smith, B.Sc., Robert Hyde (Boston Univ.),	Amherst.
Stone, B.Sc., Almon Humphrey (Boston Univ.),	Phillipston.
Thomson, B.Sc., Henry Martin (Boston Univ.),	Monterey.
Todd, Frederick Gage,	Dorchester.
White, B.Sc., Edward Albert (Boston Univ.),	Ashby.
Total,	12

Summary.

Graduate course: —		
For degree of M.S.,	3	
Four-years course: —		
Graduates of 1895,	28	
Senior class,	30	
Junior class,	23	
Sophomore class,	14	
Freshman class,	20	
Two-years course: —		
Graduates of 1895,	12	
Second year,	18	
First year,	19	
Resident graduates,	12	
Total,		179
Entered twice,		3
Total,		176

FOUR-YEARS COURSE OF STUDY.

Freshman Year.

	Agriculture.	Botany and Horticulture.	Chemistry.	Natural History.	Mathematics.	Latin and English.	French and Social Science.	Drawing and Military.
Fall, . .	- - -	Botany, structural, — 5.	- - -	- - -	Advanced algebra, — 5. Book-keeping, — 2.	English, — 2.	French, — 4.	Study of tactics, — 1.
Winter, .	History of agriculture, soils and soil formation, — 4.	- - -	- - -	- - -	Advanced algebra and geometry (plane), — 4.	English, — 2.	French, — 4.	Mechanical drawing, — 6.
Summer, .	Soils: — characteristics, improvement of, drainage, etc., — 4.	Botany, analytical, — 4.	Lectures in elementary chemistry, — 3.	- - -	Geometry (solid), — 3.	English, — 2.	French, — 3.	- -

Sophomore Year.

	Agriculture.	Botany and Horticulture.	Chemistry.	Natural History.	Mathematics.	Latin and English.	French and Social Science.	Drawing and Military.
Fall, . .	Irrigation, disposition of sewage, manures and fertilizers, — 4.	Botany, economic, and laboratory work, — 4.	Lectures in elementary chemistry, — 4.	- - -	Trigonometry, — 3.	English, — 2.	- -	- -
Winter, .	- - -	Laboratory work, — 4.	Lectures and practice, — 4.	Anatomy and physiology, — 4.	Surveying, — 3.	English, — 2.	- -	Mechanical drawing, — 4.
Summer, .	Relations of the atmosphere to plant-life, mowings, pastures, grasses, ensilage, — 5.	Horticulture, — 5.	Dry and humid qualitative analysis, — 3.	- - -	Surveying, — 4.	English, — 2.	- -	- -

JUNIOR YEAR.

	Agriculture.	Botany and Horticulture.	Chemistry.	Zoölogy.	Mathematics.	Latin and English.	French and Social Science.	Drawing and Military.
Fall, . .	Field crops, seed raising, production and improvement of varieties, machines and implements, — 4.	Market gardening, — 3.	Qualitative analysis, — 5.	Zoölogy, laboratory work, — 8.	Physics, — 2.	Rhetoric and composition, — 4.	- -	- -
Winter, .	Breeds and breeding of live stock, poultry farming, — 2.	- - -	Lectures and practice in organic chemistry, — 6.	Zoölogy, — 3.	Physics, — 3.	- -	English literature, — 4.	Descriptive geometry, — 4.
Summer, .	- - -	Landscape gardening, — 5.	The same continued, — 5.	Entomology, — 6.	Physics, — 4.	English, — 2.	- -	- -

SENIOR YEAR (ELECTIVE).*

	Agriculture.	Botany and Horticulture.	Chemistry.	Zoölogy.	Mathematics.	Latin and English.	French and Social Science.	Drawing and Military.
Fall, . .	Dairy farming, — 5.	Botany, cryptogamic, — 8.	Chemical physics and quantitative analysis, — 8.	Entomology, — 8. Veterinary science, — 5.	Engineering, — 5. Analytical geometry, — 5.	English, — 2. Advanced English, — 5. Latin, — 5.	Political economy, — 5. German, — 5.	Military science, — 1.
Winter, .	Cattle feeding, — 5.	Botany, cryptogamic, — 8.	Advanced work with lectures, — 8.	Entomology, — 8. Veterinary science, — 5.	Engineering, — 5. Differential calculus, — 5.	English, — 2. Advanced English, — 5. Latin, — 5.	Political economy, — 5. German, — 5.	Military science, — 1. Law lectures, — 1.
Summer, .	Experimental work in agriculture, — 5.	Botany, physiological, — 8.	The same continued, — 8.	Entomology, — 8. Veterinary science, — 5.	Engineering, — 5. Integral calculus, — 5.	English, — 2. Advanced English, — 5. Latin, — 5.	Constitutional history, — 5. German, — 5.	Military science, — 1.

* English and military science are required; of the other studies three at least must be chosen.

SHORT WINTER COURSES.

[All courses optional.]

AGRICULTURE.

I. General Agriculture.

1.	Soils and operations upon them, drainage, irrigation, etc.,	10
2.	Farm implements and machinery,	5
3.	Manures and fertilizers,	10
4.	Crops of the farm, characteristics, management, etc.,	10
5.	Crop rotation,	2
6.	Farm book-keeping,	5
7.	Agricultural economics,	11
8.	Farm, dairy and poultry management,	11
	Total hours,	64

II. Animal Husbandry.

1.	Introduction,	1
2.	Location and soil,	2
3.	Building,	4
4.	Breeds of cattle,*	10
5.	Breeds of horses,	6
6.	Grain and fodder crops,*	11
7.	Foods and feeding,*	11
8.	Extra,	19
	Total hours,	64

* With dairy course.

DAIRYING.

III. Lectures and Class-room Work.

1.	The soil and crops,	22
2.	The dairy breeds and cattle breeding,	22
3.	Stable construction and sanitation, care of cattle,	11
4.	Common diseases of stock, their prevention and treatment,	11
5.	Foods and feeding,	11
6.	Book-keeping for the dairy farm and butter factory,	22
7.	Pasteurization and preparation of milk on physicians' prescriptions,	11

III. Lectures, etc. — Concluded.

8.	Composition and physical peculiarities of milk; conditions which affect creaming, churning, methods of testing and preservation,	22
9.	Milk testing,	6
10.	Butter making,	12
11.	Practice in aeration, pasteurization,	6
	Total hours,	156

HORTICULTURE.

IV. Fruit Culture.

1.	Introduction,	1
2.	Propagation of fruit trees by seed, budding, grafting, forming the head, digging, planting, pruning, training, cultivation, etc.,	28
3.	Insects and fungous diseases,	3
	Total hours,	32

V. Floriculture.

1.	Greenhouse construction and heating,	6
2.	Propagation of greenhouse and other plants by seed, cuttings, grafting, etc.,	3
3.	Cultivation of rose, carnation, chrysanthemum and orchids,	12
4.	Propagation and care of greenhouse and bedding plants,	10

V. Floriculture — Concluded.

5.	Insects and fungi which attack greenhouse plants,	2
	Total hours,	33

VI. Market Gardening.

1.	Introduction, equipment, tools, manures, fertilizers, etc.,	3
2.	Greenhouse construction and heating,	6
3.	Forcing vegetables under glass,	3
4.	Seed growing by the market gardener,	3
5.	Special treatment required by each crop,	10
6.	Insects and fungi, with remedies,	2
	Total hours,	27

Botany.

VII. Lectures on Injurious Fungi of the Farm, Garden, Greenhouse, Orchard and Vineyard.

1.	Introduction,	2
2.	Nature and structure of rusts,	4
3.	Nature and structure of smuts,	4
4.	Nature and structure of mildews,	4
5.	Nature and structure of rots,	4
6.	Beneficial fungi of roots,	2
7.	Edible mushrooms,	2
	Total hours,	22

VIII. Lectures and Demonstrations on "How Plants Grow."

1.	Introduction,	1
2.	The parts of a plant,	1
3.	Structure of the cell and plant in general,	3
4.	Functions of root, stem and leaves,	3
5.	Food of plant obtained from air,	3
6.	Food of plant obtained from soil,	3
7.	Transference and elaboration of food,	2
8.	Growth of plants,	2
9.	Effects of light, moisture, heat and cold,	2
10.	Root tubercles on pea and clover,	1
11.	Cross fertilization of flowers,	1
	Total hours,	22

Chemistry.

IX. General Agricultural Chemistry.

1.	Introduction,	2
2.	The fourteen elements of agricultural chemistry,	1
3.	Rocks and soils,	8
4.	The atmosphere,	7
5.	The chemistry of crop-growing,	8
6.	Fertilizers,	8
7.	Animal chemistry,	8
	Total hours,	55

X. Chemistry of the Dairy.

1.	Introduction,	2
2.	The fourteen elements of agricultural chemistry,	14
3.	The physical properties of milk,	13
4.	Analysis of milk, butter, cheese and other dairy products,	13
5.	Chemistry of the manufacture of dairy products,	13
	Total hours,	55

Zoölogy.

XI. Animal Life on the Farm.

Total hours, ... 22

XII. Insect Friends and Foes of the Farmers.

Total hours, ... 33

GRADUATE COURSE.

1. Honorary degrees will not be conferred.

2. Applicants will not be eligible to the degree of M.S. until they have received the degree of B.S. or its equivalent.

3. The faculty shall offer a course of study in each of the following subjects: mathematics and physics; chemistry; agriculture; botany; horticulture; entomology; veterinary. Upon the satisfactory completion of any two of these the applicant shall receive the degree of M.S. This prescribed work may be done at the Massachusetts Agricultural College or at any institution which the applicant may choose; but in either case the degree shall be conferred only after the applicant has passed an examination at the college under such rules and regulations as may be prescribed.

4. Every student in the graduate course shall pay one hundred dollars to the treasurer of the college before receiving the degree of M.S.

TEXT-BOOKS.

Wood — "The American Botanist and Florist."
Bessey — "Botany for High Schools and Colleges."
Gray — "Manual."
Gray — "Structural Botany."
Bower — "Practical Botany."
Arthur, Barnes and Coulter — "Plant Dissection."
Campbell — "Structural and Systematic Botany."
Oel — "Experimental Plant Physiology."
Goodale — "Physiological Botany."
Darwin and Acton — "Practical Physiology of Plants."
Scribner — "Fungous Diseases of the Grapevine."
Vasey — "Agricultural Grasses of the United States."
Smith — "Diseases of Garden Crops."
Wolle — "Fresh-water Algæ."
Long — "How to make the Garden pay."
Long — "Ornamental Gardening for Americans."
Taft — "Greenhouse Construction."
Weed — "Insects and Insecticides."
Weed — "Fungi and Fungicides."
Fuller — "Practical Forestry."
Maynard — "Practical Fruit Grower."
McAlpine — "How to know Grasses by their Leaves."
Morton — "Soil of the Farm."
Gregory — "Fertilizers."

Mills and Shaw — "Public School Agriculture."
Miles — "Stock Breeding."
Armsby — "Manual of Cattle Feeding."
Curtis — "Horses, Cattle, Sheep and Swine."
Morrow and Hunt — "Soils and Crops."
Grotenfeld — "The Principles of Modern Dairy Practice."
Shepard — "Elementary Chemistry."
Storer — "Agriculture in its Relations to Chemistry."
Richter and Smith — "Text-book of Inorganic Chemistry."
Muter — "Analytical Chemistry."
Roscoe — "Lessons in Elementary Chemistry."
Bernthsen and McGowan — "Text-book of Organic Chemistry."
Fresenius — "Qualitative Chemical Analysis."
Fresenius — "Quantitative Chemical Analysis."
Reynolds — "Experimental Chemistry."
Sutton — "Volumetric Analysis."
Dana — "Manual of Determinative Mineralogy."
Thomson — "Commercial Arithmetic."
Meservey — "Book-keeping."
Wells — "College Algebra."
Dana — "Mechanics."
Wells — "Plane and Solid Geometry" (revised edition).
Runkle — "Plane Analytic Geometry."
Bowser — "Analytic Geometry."
Osborne — "Differential and Integral Calculus."
Wells — "Essentials of Trigonometry."
Johnson — "Theory and Practice of Surveying."
Byrne — "Highway Construction."
Jones — "Sound, Light and Heat."
Thompson — "Electricity and Magnetism."
Ayrton — "Practical Electricity."
Loomis — "Meteorology."
Martin — "Human Body" (elementary course).
Martin — "Human Body" (briefer course).
Walker — "Political Economy" (abridged edition).
Gide — "Principles of Political Economy."
Wilson — "The State, Historical and Practical Politics."
Whitney and Lockwood — "English Grammar."
Lockwood — "Lessons in English."
Genung — "Outlines of Rhetoric."
Sprague — "Six Selections from Irving's Sketch-book"
Whittier, No. 4; Longfellow, Nos. 33, 34, 35; Lowell, No. 39 — "Riverside Literature Series."
Hudson — "Selections of Prose and Poetry." Webster, Burke, Addison, Goldsmith, Shakespeare.
Paintor — "English Literature."
Whitney — "French Grammar."
Luquiens — "Popular Science."
Whitney — "German Grammar."

BOISEN — "Preparatory German Prose."
BERNHARDT — "Sprach-und Lesebuch."
HODGES — "Scientific German."
WHITE — "Progressive Art Studies."
FAUNCE — "Mechanical Drawing."
U. S. ARMY — "Infantry Drill Regulations"
U. S. ARMY — "Artillery Drill Regulations."

To give not only a practical but a liberal education is the aim in each department, and the several courses have been so arranged as to best subserve that end. Weekly exercises in composition and declamation are held throughout the course. The instruction in agriculture and horticulture is both theoretical and practical, the lessons of the recitation room being practically enforced in the garden and field. Students are allowed to work for wages during such leisure hours as are at their disposal. Under the act by which the college was founded, instruction in military tactics is imperative, and each student, unless physically debarred,* is required to attend such exercises as are prescribed, under the direction of a regular army officer stationed at the college.

FOUR-YEARS COURSE.

ADMISSION.

Candidates for admission to the freshman class will be examined, orally and in writing, upon the following subjects: English grammar, geography, United States history, physiology, physical geography, arithmetic, the metric system, algebra (through quadratics), geometry (two books) and civil government (Mowry's "Studies in Civil Government"). The standard required is 65 per cent on each paper. Diplomas from high schools will *not* be received in place of examination. Examination in the following subjects may be taken a year before the candidate expects to enter college: English grammar, geography, United States history, physical geography and physiology. Satisfactory examination in a substantial part of the subjects offered will be required, that the applicant may have credit for this preliminary examination.

Candidates for higher standing are examined as above, and also in the studies gone over by the class to which they desire admission.

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* Certificates of disability must be procured of Dr. Herbert B. Perry of Amherst.

No one can be admitted to the college until he is sixteen years of age. The regular examinations for admission are held at the Botanic Museum, at 9 o'clock A.M., on Thursday and Friday, June 18 and 19, and on Tuesday and Wednesday, September 1 and 2; but candidates may be examined and admitted at any other time in the year. For the accommodation of those living in the eastern part of the State, examinations will also be held at 9 o'clock A.M., on Thursday and Friday, June 18 and 19, at Jacob Sleeper Hall, Boston University, 12 Somerset Street, Boston; and for the accommodation of those in the western part of the State, at the same date and time, at the Sedgwick Institute, Great Barrington, by James Bird. Two full days are required for examination, and candidates must come prepared to stay that length of time.

TWO-YEARS COURSE.

At the regular annual meeting of the trustees, held Dec. 31, 1895, the following votes were passed: —

That the two-years course be discontinued, with the understanding that those who have already entered upon it be allowed to complete the same.

That short winter courses of eleven weeks, in agriculture, botany, chemistry, dairying, floriculture, horticulture, market gardening and zoölogy, be established after the close of the present collegiate year.

That a special course in dairying be established Jan. 1, 1896.

WINTER COURSES.

For these short winter courses examinations are not required. They commence the first Wednesday in January and end the third Wednesday in March. Candidates must be at least sixteen years of age. The doors of the college are opened to applicants from both sexes. The same privileges in regard to room and board will obtain as with other students. Attendance upon general exercises is required. Residents of the State will be required to pay the usual fees for apparatus and material used in laboratory work. Those not residents of the State will be required to pay, in addition, a tuition fee.

ENTRANCE EXAMINATION PAPERS USED IN 1895.

The standard required is 65 per cent on each paper.

Four-years Course.

Arithmetic and the Metric System.

1. Write the prime numbers between 1 and 20. Write in Roman notation 1,659.
2. What is the greatest common divisor of 126, 210, 252?
3. $\frac{3}{4}+\frac{1}{5}+1\frac{1}{8}-1\frac{5}{6}=$?
4. At 20 cents per square inch, what will be the cost of 3 square yards, 1 square foot and 9 square inches of gold leaf?
5. If $\frac{4}{9}$ of a farm sold for $\frac{5}{8}$ of what it cost, what is the gain per cent?
6. What is the bank discount of $586 for 3 months at 6 per cent? What are the proceeds ?
7. If 8 men can dig a ditch 60 feet long, 8 feet wide and 6 feet deep in 15 days, how many days will 24 men require to dig a ditch 80 feet long, 3 feet wide and 8 feet deep ?
8. What is the square root of 62,001?
9. Name the three principal units of the metric system, and give their English equivalents.
10. Express the sum of the following in metres: 9.5 K.m., 37 D.m., 6.347 H.m., 378.6 cm.
11. In 387 cm. how many feet ?
12. How much will it cost to fence a hectare of land that is in the form of a square, at 10 cents per metre ?

Algebra.

1. What are the prime factors of $14x^2+29x-15$? of $(a+b)^2-c^2$?
2. $\left(\dfrac{x^5+2x^4y-x^2y^3+3x^3y^2-3y^5-2xy^4}{x^3-y^3}\right)=$?
3. Solve for x and y in, $\dfrac{5}{x}+\dfrac{16}{y}=79$ and $\dfrac{16}{x}-\dfrac{1}{y}=44$.
4. $\sqrt[3]{27+108x+90x^2-80x^3-60x^4+48x^5-8x^6}=$?
5. Expand $(3a^2+4b^3)^5$.
6. Rationalize $\dfrac{\sqrt{x^2+1}+\sqrt{x^2-1}}{\sqrt{x^2+1}-\sqrt{x^2-1}}+\dfrac{\sqrt{x^2+1}-\sqrt{x^2-1}}{\sqrt{x^2+1}+\sqrt{x^2-1}}$.

7. $x + \sqrt{1 + x^2} = \frac{2}{\sqrt{1 + x^2}}$ solve for x.

8. Solve for x and y.

$$x^2 + xy - 2y^2 = -44$$
$$xy + 3y^2 = 80.$$

Geometry.

1. What is a scalene triangle, an isosceles triangle, an equiangular triangle?

2. What is the complement of an angle? A supplement of an angle? Find the complement of 35°, of $47\frac{1}{2}°$; find the supplement of 10° 29′, of 144°.

Prove the following: —

3. If oblique lines be drawn from a point to a straight line, two equal oblique lines cut off equal distances from the foot of the perpendicular from the point to the line.

4. The sum of the angles of any triangle is equal to two right angles.

5. Any point in the bisector of an angle is equally distant from the sides of the angle.

6. In the same circle or equal circles chords equally distant from the centre are equal.

7. The two tangents to a circle from an outside point are equal.

8. The angle between a tangent and a chord is measured by $\frac{1}{2}$ of its intercepted arc.

United States History.

NOTE. — Penmanship, spelling, capitalization and punctuation will be considered in determining the excellence of your paper.

1. What were the causes of the founding of the colony at Jamestown in Virginia in 1607?

2. Tell what you know about Roger Williams.

3. What were the causes of the Revolution? Give the dates of this war, and name three important battles in it.

4. Who was John Paul Jones?

5. Tell of the part played by our navy in the War of 1812. What ship that took part in this war, on the American side, is afloat to-day?

6. Give the date of the Missouri compromise, and tell what it was.

7. What has been the condition of the South since the Civil War?

8. What important event in our history is to be associated with each of the following names: Quebec, Plymouth, Philadelphia, Charleston, West Point?

9. Name five great American generals; five great American naval commanders.

10. What important questions are now before our government?

Geography.

NOTE. — Penmanship, spelling, capitalization and punctuation will be considered in determining the excellence of your paper.

1. Draw a map of New England, and locate on it the following: the boundaries of each State, the White Mountains, Boston, Hartford, Gloucester, Augusta, Burlington, Springfield, Merrimac River, Connecticut River.

2. What is the largest desert in the world? the largest island? the highest mountain?

3. Name the Great Lakes in the order of their size, and state upon which of them the following cities are placed: Chicago, Niagara, Toronto, Detroit.

4. Name the political divisions of the Dominion of Canada.

5. Locate Madagascar, Tokyo, Cape Town, Nicaragua, Edinburgh, Hamburg, Poland.

6. What country has the largest system of railroads? The largest foreign commerce? The largest united area? The largest population?

7. Describe the United Kingdom of Great Britain, telling of its (*a*) divisions, (*b*) geographical features, (*c*) products.

8. Name the oceans in the order of their size. What part of the earth's surface does the water cover?

9. Define strait, peninsula, water-shed, lake, harbor.

10. What kind of a government has England? France? Russia? Brazil? Turkey?

Physical Geography.

NOTE. — Penmanship, spelling, capitalization and punctuation will be considered in determining the excellence of your paper.

1. Define physical geography.

2. What is the exact form of the earth? Give the proportion of land and water.

3. Define erosion, alluvial plain, delta, cañon.

4. What is a glacier? Define the terms lateral moraine, terminal moraine.

5. Can rivers and glaciers be compared? How? Have they a similar action on the earth's surface?

6. What are ocean currents? Name some. Give some causes.

7. Give two methods of mountain forming. Give examples of mountain ranges formed by each method.

8. What is climate? Give some causes which influence climate.

9. How are coral islands formed? Define an atoll, barrier reef, fringing reef.

10. What is a volcano? Where are they principally found?

Civil Government.

NOTE. — Penmanship, spelling, capitalization and punctuation will be considered in determining the excellence of your paper.

1. Why is any government necessary in the United States today?

2. Who make the laws for the government of the town in which you live? for the State? for the nation?

3. Name three kinds of colonial governments found in America prior to the Revolution, and the colonies that were under each.

4. When did the American republic, with its national organization, commence? When did the States cease to be colonies and become States?

5. In what body was the government vested during most of the Revolutionary War? What were the Articles of Confederation?

6. In what year was the Constitution of the United States framed? In what year did it go into effect? Where was the first President inaugurated?

7. Into what departments is the government of the United States divided? State the length of the term of office of the following: a member of the National House of Representatives; the President of the United States; a United States Senator?

8. Of how many members does the United States Senate now consist? Who is its presiding officer? Name the United States Senators from Massachusetts.

9. What is the title of the chief executive officer (or officers) of the town? of the State? of the nation?

10. Define the word *citizen*.

Physiology.

NOTE. — Penmanship, spelling, capitalization and punctuation will be considered in determining the excellence of your paper.

1. Define hygiene, anatomy, physiology.
2. What is a cell? a tissue? an organ?
3. Name the bones of the leg. Compare them with those of the arm.
4. What is a muscle? How do muscles bring about movement between bones?
5. Give uses of the skin, the kidneys.
6. Define digestion, absorption, assimilation.
7. Describe the alimentary tract.
8. What is the blood? Give its uses. What is lymph?
9. What is the brain? Name the different parts. What is the special function of each?
10. What is a man? What is his place in nature?

English Grammar and Composition.

NOTE. — Penmanship, spelling, capitalization and punctuation will be considered in determining the excellence of your paper.

1. State *clearly* and *briefly* what preparation you have had in grammar and rhetoric, naming, if possible, the text-books.

2. Write a simple sentence, a compound sentence, a complex sentence.

3. Name the parts of speech, define each, and give examples of each.

4. Correct the following, *stating reasons:* —

(*a*) You and me will admire our supper.

(*b*) The opinion of a thousand men were against him.

(*c*) Charles can draw the roundest circle I ever see.

(*d*) "Did the boss jump on you?"
"Well, I should smile!"
"You're not onto his little job, are you?"
"You bet your hat I am!"

(*e*) The boat was anchored at the wharf, and we got in and the rope was untied so that the oars could be placed in the row-locks which were fastened to this rope.

5. Compare beautiful, honest, bitter, deep, awful.

6–10. Put the following poem into good English prose, neither omitting nor adding anything: —

At anchor in Hampton Roads we lay,
On board of the "Cumberland," sloop-of-war;
And at times from the fortress across the bay
The alarum of drums swept past,
Or a bugle blast
From the camp on the shore.

Then far away to the south uprose
A little feather of snow-white smoke,
And we knew that the iron ship of our foes
Was steadily steering its course
To try the force
Of our ribs of oak.

Down upon us heavily she runs,
Silent and sullen, the floating fort.
Then comes a puff of smoke from her guns,
And leaps the terrible death
With fiery breath
From each open port.

We are not idle, but send her straight
Defiance back in a full broadside.
As hail rebounds from a roof of slate,
Rebounds our heavier hail
From each iron scale
Of the monster's hide.

. . . .

Then like a Kraken huge and black,
She crushed our ribs in her iron grasp.
Down went the "Cumberland" all a wrack,
With a sudden shudder of death,
And the cannon's breath
For her dying gasp.

DEGREES.

Those who complete the four-years course receive the degree of Bachelor of Science, the diploma being signed by the governor of Massachusetts, who is the president of the corporation.

Regular students of the college may also, on application, become members of Boston University, and upon graduation receive its diploma in addition to that of the college, thereby becoming entitled to all the privileges of its alumni.

Those completing the graduate course receive the degree of Master of Science. A certificate signed by the president of the college will be awarded to those completing the two-years course.

EXPENSES.

Tuition in advance: —			
Fall term,	$30 00		
Winter term,	25 00		
Summer term,	25 00		
		$80 00	$80 00
Room rent, in advance, $8 to $16 per term,		24 00	48 00
Board, $2.50 to $5 per week,		95 00	190 00
Fuel, $5 to $15,		5 00	15 00
Washing, 30 to 60 cents per week,		11 40	22 80
Military suit,		15 75	15 75
Expenses per year,		$231 15	$371 55

Board in clubs has been about $2.45 per week; in private families, $4 to $5. The military suit must be obtained immediately upon entrance at college, and used in the drill exercises prescribed. The following fees will be charged for the maintenance of the several laboratories: chemical, $10 per term used; zoölogical, $4 per term used; botanical, $1 per term used by sophomore class, $2 per term used by senior class; entomological, $2 per term used. Some expense will also be incurred for lights and text-books. Students whose homes are within the State of Massachusetts can in most cases obtain a scholarship by applying to the senator of the district in which they live.

THE LABOR FUND.

The object of this fund is to assist those students who are dependent either wholly or in part on their own exertions, by furnishing them work in the several departments of the college. The greatest opportunity for such work is found in the agricultural and horticultural departments. Application should be made to Profs. William P. Brooks and Samuel T. Maynard, respectively in charge of said departments. Students desiring to avail themselves of its benefits must bring a certificate signed by one of the selectmen of the town in which they are resident, certifying to the fact that they require aid.

ROOMS.

All students, except those living with parents or guardians, will be required to occupy rooms in the college dormitories.

For the information of those desiring to carpet their rooms, the

following measurements are given: in the new south dormitory the study rooms are about fifteen by fourteen feet, with a recess seven feet four inches by three feet; and the bedrooms are eleven feet two inches by eight feet five inches. This building is heated by steam. In the north dormitory the corner rooms are fourteen by fifteen feet, and the annexed bedrooms eight by ten feet. The inside rooms are thirteen and one-half by fourteen and one-half feet, and the bedrooms eight by eight feet. A coal stove is furnished with each room. Aside from this, all rooms are unfurnished. Mr. Thomas Canavan has the general superintendence of the dormitories, and all correspondence relative to the engaging of rooms should be with him.

SCHOLARSHIPS.

Established by Private Individuals.

Mary Robinson Fund of one thousand dollars, the bequest of Miss Mary Robinson of Medfield.

Whiting Street Fund of one thousand dollars, the bequest of Whiting Street, Esq., of Northampton.

Henry Gassett Fund of one thousand dollars, the bequest of Henry Gassett, Esq., of North Weymouth.

The income of the above funds is assigned by the faculty to worthy students requiring aid.

CONGRESSIONAL SCHOLARSHIPS.

The trustees voted in January, 1878, to establish one free scholarship for each of the congressional districts of the State. Application for such scholarships should be made to the representative from the district to which the applicant belongs. The selection for these scholarships will be determined as each member of Congress may prefer; but, where several applications are sent in from the same district, a competitive examination would seem to be desirable. Applicants should be good scholars, of vigorous constitution, and should enter college with the intention of remaining through the course, and then engaging in some pursuit connected with agriculture.

STATE SCHOLARSHIPS.

The Legislature of 1883 passed the following resolve in favor of the Massachusetts Agricultural College: —

Resolved, That there shall be paid annually, for the term of four years, from the treasury of the Commonwealth to the treasurer of the Massachusetts Agricultural College, the sum of ten thousand dollars, to enable the trustees of said college to provide for the students of said institution the theoretical and practical education required by its charter and the law of the United States relating thereto.

Resolved, That annually, for the term of four years, eighty free scholarships be and hereby are established at the Massachusetts Agricultural College, the same to be given by appointment to persons in this Commonwealth, after a competitive examination, under rules prescribed by the president of the college, at such time and place as the senator then in office from each district shall designate; and the said scholarships shall be assigned equally to each senatorial district. But, if there shall be less than two successful applicants for scholarships from any senatorial district, such scholarships may be distributed by the president of the college equally among the other districts, as nearly as possible; but no applicant shall be entitled to a scholarship unless he shall pass an examination in accordance with the rules to be established as hereinbefore provided.

The Legislature of 1886 passed the following resolve, making perpetual the scholarships established: —

Resolved, That annually the scholarships established by chapter forty-six of the resolves of the year eighteen hundred and eighty-three be given and continued in accordance with the provisions of said chapter.

In accordance with these resolves, any one desiring admission to the college can apply to the senator of his district for a scholarship. Blank forms of application will be furnished by the president.

EQUIPMENT.

Agricultural Department.

The Farm. — Among the various means through which instruction in agriculture is given, none exceeds in importance the farm. The part which is directly under the charge of the professor of agriculture comprises about one hundred and fifty acres of im-

proved land and thirty acres of woodland. Of the improved land, about thirty acres are kept permanently in grass. A considerable part of this is laid off in half and quarter acre plats, and variously fertilized with farm-yard and stable manures and chemicals, with a view to throwing light upon the economical production of grass. These plats are staked and labelled, so that all may see exactly what is being used and what are the results.

The rest of the farm is managed under a system of rotation, all parts being alternately in grass and hoed crops. All the ordinary crops of this section are grown, and many not usually seen upon Massachusetts farms find a place here. Our large stock of milch cows being fed almost entirely in the barn, fodder crops occupy a prominent place. Experiments of various kinds are continually under trial; and every plat is staked, and bears a label stating variety under cultivation, date of planting, and manures and fertilizers used.

Methods of land improvement are constantly illustrated here, tile drainage especially receiving a large share of attention. There are now some nine miles of tile drains in successful and very satisfactory operation upon the farm. Methods of clearing land of stumps are also illustrated, a large amount of such work having been carried on during the last few years.

In all the work of the farm the students are freely employed, and classes are frequently taken into the fields; and to the lessons to be derived from these fields the students are constantly referred.

The Barn and Stock. — Our commodious barns contain a large stock of milch cows, many of which are grades; but the following pure breeds are represented by good animals, viz., Holstein-Friesian, Ayrshire, Jersey, Guernsey and Shorthorn. Experiments in feeding for milk and butter are continually in progress. We have a fine flock of Southdown sheep and a few choice specimens of the Shropshire, Horned Dorset, Cotswold and Merino breeds. Swine are represented by the Chester White, Poland China, Middle Yorkshire and Tamworth breeds. Besides work horses, we have a number of pure-bred Percherons, used for breeding as well as for work.

The barn is a model of convenience and labor-saving arrangements. It illustrates different methods of fastening animals, various styles of mangers, watering devices, etc. Connected with it are a plant for electric light and power and commodious storage rooms for vehicles and machines. It contains silos and a granary. A very large share of the work is performed by students, and whenever points require illustration, classes are taken to it for that purpose.

Dairy School. — Connected with the barn is a wing providing accommodation for practical and educational work in dairying. The wing contains one room for heavy dairy machinery, another for lighter machinery, both large enough to accommodate various styles of all prominent machines; a large ice house, a cold-storage room and a room for raising cream by gravity methods, a class room and a laboratory. The power used is an electric motor. This department is steam heated and piped for hot and cold water and steam. In this department has been placed a full line of modern dairy machinery, so that we are able to illustrate all the various processes connected with the creaming of milk, its preparation for market and the manufacture of butter. Special instruction in such work is offered in the dairy course.

Equipment of Farm. — Aside from machines and implements generally found upon farms, the more important of those used upon our farm and in our barn which it seems desirable to mention are the following: reversible sulky plough, broadcast fertilizer distributer, manure spreader, grain drill, horse corn planter, potato planter, wheelbarrow grass seeder, hay loader, potato digger, hay press, fodder cutter and crusher and grain mill. It is our aim to try all novelties as they come out, and to illustrate everywhere the latest and best methods of doing farm work.

Lecture Room. — The agricultural lecture room in south college is well adapted to its uses. It is provided with numerous charts and lantern slides, illustrating the subjects taught. Connected with it are two small rooms at present used for the storage of illustrative material, which comprises soils in great variety, all important fertilizers and fertilizer materials, implements used in the agriculture of our own and other countries, and a collection of grasses and forage plants, grains, etc.

A valuable addition to our resources consists of a full series of Landsberg's models of animals. These are accurate models of selected animals of all the leading breeds of cattle, horses, sheep and swine, from one-sixth to full size, according to subject. We are provided with a complete collection of seeds of all our common grasses and the weeds which grow in mowings, and have also a large collection of the concentrated food stuffs. All these are continually used in illustration of subjects studied.

Museum. — An important beginning has been made towards accumulating materials for an agricultural museum. This is to contain the rocks from which soils have been derived, soils, fertilizer materials and manufactured fertilizers, seeds, plants and their products, stuffed animals, machines and implements. It is expected to make this collection of historical importance by includ-

ing in it old types of machines and implements, earlier forms of breeds, etc. For lack of room the material thus far accumulated is stored in a number of scattered localities, and much of it where it cannot be satisfactorily exhibited.

Botanic Department.

Course of Study. — This department is well equipped to give a comprehensive course in most of the subjects of botany. The course aims to treat of all the more important features connected with the study of plants which have a close bearing upon agriculture, without at the same time deviating from a systematic and logical plan. Throughout the entire course the objective methods of teaching are followed, and the student is constantly furnished with an abundance of plant material for practical study, together with an elaborate series of preserved specimens for illustration and comparison. In the freshman year the study of structural and systematic botany is pursued, with some observation on insect fertilization. This is followed in the first term of the sophomore year by the systematic study of grasses, trees and shrubs, and this during the winter term by an investigation into the microscopic structure of the plant. The senior year is given up entirely to cryptogamic and physiological botany.

The Botanic Museum contains the Knowlton herbarium, of over ten thousand species of phanerogamous and the higher cryptogamous plants; about five thousand species of fungi, and several collections of lichens and mosses, including those of Tuckerman, Frost, Denslow, Cummings, Müller and Schaerer. It also contains a large collection of native woods, cut so as to show their individual structure; numerous models of native fruits; specimens of abnormal and peculiar forms of stems, fruits, vegetables, etc.; many interesting specimens of unnatural growths of trees and plants, natural grafts, etc.; together with models for illustrating the growth and structure of plants, and including a model of the squash which raised by the expansive force of its growing cells the enormous weight of five thousand pounds.

The Botanic Lecture Room, in the same building, is provided with diagrams and charts of over three thousand figures, illustrating structural, systematic and physiological botany.

The Botanic Laboratory, with provision for twenty-five students to work at one time, is equipped with Leitz', Reichert's, Bausch and Lomb's, Beck's, Queen's and Tolles' compound microscopes, with objectives varying from four inch to one-fifteenth inch focal length, and also with a few dissecting microscopes. It also con-

tains a DuBois Raymond induction apparatus, a Thoma and a Beck microtome, a self-registering thermometer, a Wortmann improved clinostat and also one of special construction, an Arthur centrifugal apparatus with electric motor, a Pfeffer-Baranetzky electrical self-registering auxanometer, a Sach's arc-auxanometer, a horizontal reading microscope (Pfeffer model), various kinds of dynamometers of special construction, respiration appliances, mercurial sap and vacuum gauges, manometers, gas and exhaust chambers, a Bausch and Lomb micro-photographic camera, a Clay landscape camera and dark closet fitted for work, besides various other appliances for work and demonstration in plant physiology.

Horticultural Department.

Greenhouses. — To aid in the instruction of botany, as well as that of floriculture and market gardening, the glass structures contain a large collection of plants of a botanical and economic value, as well as those grown for commercial purposes. They consist of a large octagon, forty by forty feet, with sides twelve feet high and a central portion over twenty feet high, for the growth of large specimens, like palms, tree ferns, the bamboo, banana, guava, olive, etc.; a lower octagon, forty by forty feet, for general greenhouse plants; a moist stove, twenty-five feet square; a dry stove of the same dimensions; a rose room, twenty-five by twenty feet; a room for aquatic plants, twenty by twenty-five feet; a room for ferns, mosses and orchids, eighteen by thirty feet; a large propagating house, fifty by twenty-four feet, fitted up with benches sufficient in number to accommodate fifty students at work at one time; a vegetable house, forty-two by thirty-two feet; two propagating pits, eighteen by seventy-five feet, each divided into two sections for high and low temperatures, and piped for testing overhead and under-bench heating; a cold grapery, eighteen by twenty-five feet. To these glass structures are attached three workrooms, equipped with all kinds of tools for greenhouse work. In building these houses as many as possible of the principles of construction, heating, ventilating, etc., have been incorporated for the purposes of instruction.

Orchards. — These are extensive, and contain nearly all the valuable leading varieties, both old and new, of the large fruits, growing under various conditions of soil and exposure.

Small Fruits. — The small fruit plantations contain a large number of varieties of each kind, especially the new and promising ones, which are compared with older sorts, in plots and in field culture. Methods of planting, pruning, training, cultivation,

study of varieties, gathering, packing and shipping fruit, etc., are taught by field exercises, the students doing a large part of the work of the department.

Nursery. — This contains more than five thousand trees, shrubs and vines, in various stages of growth, where the different methods of propagation by cuttings, layers, budding, grafting, pruning and training are practically taught to the students.

Garden. — All kinds of garden and farm-garden crops are grown in this department, furnishing ample illustration of the treatment of market-garden crops. The income from the sales of trees, plants, flowers, fruit and vegetables aids materially in the support of the department, and furnishes illustrations of the methods of business, with which all students are expected to become familiar.

Forestry. — Many kinds of trees suitable for forest planting are grown in the nursery, and plantations have been made upon the college grounds and upon private estates in the vicinity, affording good examples of this most important subject. A large forest grove is connected with this department, where the methods of pruning trees and the management and preservation of forests can be illustrated. In the museum and lecture room are collections of native woods, showing their natural condition and peculiarities; and there have been lately added the prepared wood sections of R. B. Hough, mounted on cards for class-room illustration.

Ornamental trees, shrubs and flowering plants are grouped about the grounds in such a way as to afford as much instruction as possible in the art of landscape gardening. All these, as well as the varieties of large and small fruits, are marked with conspicuous labels, giving their common and Latin names, for the benefit of the students and the public.

Tool House. — A tool house, thirty by eighty feet, has been constructed, containing a general store-room for keeping small tools; a repair shop with forge, anvil and work bench; and a carpenter shop equipped with a large Sloyd bench and full set of tools. Under one-half of this building is a cellar for storing fruit and vegetables. In the loft is a chamber, thirty by eighty feet, for keeping hot-bed sashes, shutters, mats, berry crates, baskets and other materials when not in use.

Connected with the stable is a cold-storage room, with an ice chamber over it, for preserving fruit, while the main cellar underneath the stable is devoted to the keeping of vegetables.

All the low land south of the greenhouses has been thoroughly underdrained and put into condition for the production of any garden or small fruit crop.

Zoölogical Department.

Zoölogical Lecture Room. — The room in south college is well adapted for lecture and recitation purposes, and is supplied with a series of zoölogical charts prepared to order, also a set of Leuckart's charts, disarticulated skeletons and other apparatus for illustration.

Zoölogical Museum. — This is in immediate connection with the lecture room, and contains the Massachusetts State collection, which comprises a large number of mounted mammals and birds, together with a series of birds' nests and eggs, a collection of alcoholic specimens of fishes, reptiles and amphibians, and a collection of shells and other invertebrates.

There is also on exhibition in the museum a collection of skeletons of our domestic and other animals, and mounted specimens purchased from Prof. H. A. Ward; a series of glass models of jelly fishes, worms, etc., made by Leopold Blaschka in Dresden; a valuable collection of corals and sponges from Nassau, N. P., collected and presented by Prof. H. T. Fernald; a fine collection of corals, presented by the Museum of Comparative Zoölogy in Cambridge; a collection of alcoholic specimens of invertebrates from the coast of New England, presented by the National Museum at Washington; a large and rapidly growing collection of insects of all orders; and a large series of clastic models of various animals, manufactured in the Auzoux laboratory in Paris.

It is the purpose of those in charge to render the museum as valuable to the student as possible; and with this end in view the entire collection has been rearranged so as to present a systematic view of the entire animal kingdom, with special regard to the fauna of Massachusetts. In the furtherance of this idea a special case has been prepared, in which are shown typical animals in such a way as to give a brief synopsis of the entire animal kingdom, forming a sort of index to the museum as a whole. In order to render our collection complete, particularly with reference to Massachusetts forms, we would gratefully receive donations of any sort, either alcoholic or otherwise preserved, especially among the worms, fishes, amphibians or reptiles. Specimens should be sent care of Prof. R. S. Lull. The museum is now open to the public from three to four P.M. every day except Sunday.

Zoölogical Laboratory. — A large room in the laboratory building has been fitted up for a zoölogical laboratory, with tables, sink, gas, etc., and is supplied with a reference library, microscopes, chemical and other necessary apparatus for work. This laboratory

with its equipment is undoubtedly the most valuable appliance for instruction in the department of zoölogy.

Entomological Laboratory. — An entomological laboratory was built adjoining the insectary the past summer, and completed ready for use at the beginning of the fall term. It is a two-story building, thirty-two by thirty-six feet on the ground, with a laboratory, lecture room, office, hall, apparatus and re-agent rooms on the first floor, and two private laboratories for advanced work, photographing room, with a dark room adjoining, janitor's room and hall on the second floor, while the large attic furnishes ample store room. This building, together with the insectary and greenhouse connected with it, are heated with a hot-water system, so arranged that any part may be shut off, and the remaining rooms heated when desired. Plans of this building were published in the report for 1895, on pages 14 and 15.

The laboratory occupies the whole northern and eastern portion of the first floor, which is well supported by brick piers, to prevent, as far as possible, any jar that would interfere with the microscopical and other delicate work that may be going on. The room is furnished with tables built especially for the kind of work to be done, and equipped with all the apparatus necessary for the needs of the student. A door from the office opens into the library of the insectary, in which are the leading works on economic entomology and a very complete card-catalogue of the literature of North American insects.

Veterinary Department.

This department is well equipped with the apparatus necessary to illustrate the subject in the class-room.

It consists of an improved Auzoux model of the horse, imported from Paris, constructed so as to separate and show in detail the shape, size, structure and relations of the different parts of the body; two *papier-maché* models of the hind legs of the horse, showing diseases of the soft tissues, — wind-galls, bogs, spavins, etc., also the diseases of the bone tissues, — splints, spavins and ringbones; two models of the foot, one according to Bracy Clark's description, the other showing the Charlier method of shoeing and the general anatomy of the foot; a full-sized model of the bones of the hind leg, giving shape, size and position of each individual bone; thirty-one full-sized models of the jaws and teeth of the horse and fourteen of the ox, showing the changes which take place in these organs as the animals advance in age.

There is an articulated skeleton of the famous stallion, Blackhawk, a disarticulated one of a thoroughbred mare, besides one

each of the cow, sheep, pig and dog; two prepared dissections of the fore and hind legs of the horse, showing position and relation of the soft tissues to the bones; a *papier-maché* model of the uterus of the mare and of the pig; a gravid uterus of the cow; a wax model of the uterus, placenta and fœtus of the sheep, showing the position of the fœtus and the attachment of the placenta to the walls of the uterus.

In addition to the above there is a growing collection of pathological specimens of both the soft and osseous tissues, and many parasites common to the domestic animals. A collection of charts and diagrams especially prepared for the college is used in connection with lectures upon the subject of anatomy, parturition and conformation of animals.

Through the kindness of Mr. Henry Adams of Amherst the department has received a large sample collection of the various drugs used in the treatment of the diseases of the domestic animals.

For the benefit of the students, sick or diseased animals are frequently shown them, and operations performed in connection with the class-room work. For the use of the instructor of this department a laboratory has been provided in the old chapel building. It has been equipped with the apparatus necessary for the study of histology, pathology and bacteriology, consisting in part of an improved Zeiss microscope with a one-eighteenth inch objective, together with the lower powers; a Lautenschlager's incubator and hot-air sterilizer; an Arnold's steam sterilizer and a Bausch and Lomb improved laboratory microtome. This apparatus is used for the preparation of material for the class-room and for general investigation.

Mathematical Department.

In view of the fact that the course of study pursued in the mathematical department has been considerably modified within the past year, it may be proper to explain, in some detail, the course as outlined at present.

At first glance it might appear that mathematics would play a very small part in the curriculum of an agricultural college, and, while it is true that its chief object is of a supplementary nature, it is equally true that, entirely aside from its value as a means of mental discipline, mathematics has a well-defined and practical object to accomplish. In this day of scientific experiment, observation and research on the farm, the advantages of a thorough knowledge of the more elementary branches of mathematics, general physics and engineering must be more than ever apparent;

and it is to meet the needs of the agricultural college student in these lines that the work in the mathematical department has been planned.

The mathematics of the freshman, sophomore and junior years are required, those of the senior year elective.

A glance at the schedule of studies will show the sequence of subjects: book-keeping, algebra, geometry and mechanical drawing in the freshman year; trigonometry, mechanical drawing and plane surveying — the latter embracing lectures and field work in elementary engineering, the use of instruments, computation of areas, levelling, etc. — in the sophomore year; general physics — including mechanics, electricity, sound, light and heat — and descriptive geometry or advanced mechanical drawing in the junior year; and, finally, two electives in the senior year, — mathematics and engineering respectively.*

The mathematical option includes the following subjects: fall term, plane analytic geometry, embracing a study of the equations and properties of the point, line and circle, and of the parabola, ellipse and hyperbola; winter term, differential calculus; and summer term, integral calculus.

The senior engineering option is designed to give to the student the necessary engineering training to enable him to take up and apply, on the lines of landscape engineering and the development of property, his knowledge of agriculture, forestry, botany and horticulture. It embraces a course of lectures, recitations and field work on the following subjects: topography, railroad curves, earth work, construction and maintenance of roads, water works and sewerage systems, etc.

It is believed that the engineering elective will equip the student to enter a comparatively new field, that of landscape engineering, which is coming more and more prominently before the public attention; for, with the increasing consideration which is being paid to the public health and the development and beautifying of our towns and cities, come fresh needs and opportunities.

Chemical Department.

Instruction in general, agricultural and analytical chemistry and mineralogy is given in the laboratory building. Thirteen commodious rooms, well lighted and ventilated and properly fitted, are occupied by the chemical department.

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* While these two electives are entirely distinct, the student electing engineering is strongly advised to elect mathematics also.

The lecture room, on the second floor, has ample seating capacity for seventy students. Immediately adjoining it are four smaller rooms, which serve for storing apparatus and preparing material for the lecture table.

The laboratory for beginners is a capacious room on the first floor. It is furnished with forty working tables. Each table is provided with sets of wet and dry re-agents, a fume chamber, water, gas, drawer and locker, and apparatus sufficient to render the student independent of carelessness or accident on the part of others working near by; thus equipped, each worker has the opportunity, under the direction of an instructor, of repeating the processes which he has previously studied in the lecture room, and of carrying out at will any tests which his own observation may suggest.

A systematic study of the properties of elementary matter is here taken up, then the study of the simpler combinations of the elements and their artificial preparation; then follows qualitative analysis of salts, minerals, soils, fertilizers, animal and vegetable products.

The laboratory for advanced students has been fitted up in the room previously known as the chapel. Here tables for thirty workers, with adequate apparatus, have been arranged. This is for instruction in the chemistry of various manufacturing industries, especially those of agricultural interest, as the production of sugar, starch fibres and dairy products; the preparation of plant and animal foods, their digestion, assimilation and economic use; the official analysis of fertilizers, fodders and foods; the analysis of soils and waters, of milk, urine and other animal and vegetable products.

The balance room has four balances and improved apparatus for determining densities of solids, liquids and gases.

Apparatus and Collections. — Large purchases of apparatus have recently been made. Deficiencies caused by the wear and breakage of several years have been supplied and the original outfit increased. The various rooms are furnished with an extensive collection of industrial charts, including Lenoir & Foster's series and those of Drs. Julius and George Schroeder. The apparatus includes balances, a microscope, spectroscope, polariscope, photometer, barometer and numerous models and sets of apparatus. A valuable and growing collection of specimens and samples, fitted to illustrate different subjects taught, is also provided. This includes rocks, minerals, soils, raw and manufactured fertilizers, foods, including milling products, fibres and other vegetable and animal products and artificial preparations of mineral and organic

compounds. Series of preparations are used for illustrating the various stages of various manufactures from raw materials to finished products.

Library.

This now numbers 17,080 volumes, having been increased during the year, by gift and purchase, 1,280 volumes. It is placed in the lower hall of the chapel-library building, and is made available to the general student for reference or investigation. It is especially valuable as a library of reference, and no pains will be spared to make it complete in the departments of agriculture, horticulture, botany and the natural sciences. It is open a portion of each day for consultation, and an hour every evening for the drawing of books.

PRIZES.

Burnham Rhetorical Prizes.

These prizes are awarded for excellence in declamation, and are open to competition, under certain restrictions, to members of the sophomore and freshman classes.

Flint Prizes.

Mr. Charles L. Flint of the class of 1881 has established two prizes, one of thirty dollars and another of twenty dollars, to be awarded, at an appointed time during commencement week, to the two members of the junior class who may produce the best orations. Excellence in both composition and delivery is considered in making the award.

Grinnell Agricultural Prizes.

Hon. William Claflin of Boston has given the sum of one thousand dollars for the endowment of a first and second prize, to be called the Grinnell agricultural prizes, in honor of George B. Grinnell, Esq., of New York. These two prizes are to be paid in cash to those two members of the graduating class who may pass the best written and oral examination in theoretical and practical agriculture.

Hills Botanical Prizes.

For the best herbarium collected by a member of the class of 1896 fifteen dollars is offered, and for the second best a prize of ten dollars; also a prize of five dollars for the best collection of dried plants from the college farm.

The prizes in 1895 were awarded as follows: —

Burnham Rhetorical Prizes: John A. Emrich (1897), first; George D. Leavens (1897), second; Willis S. Fisher (1898), first; Randall D. Warden (1898), second.

Flint Oratorical Prizes: Frank E. DeLuce (1896), first; Frank L. Clapp (1896), second.

Grinnell Agricultural Prizes: Wright A. Root (1895), first; Clarence B. Lane (1895), second; George A. Billings (1895), third.

Hills Botanical Prizes: Harold L. Frost (1895), first; Frederick C. Tobey (1895), second.

Collection of Woods: Harold L. Frost (1895).

Collection of Dried Plants: Harold L. Frost (1895).

Military Prize: Gold Medal, presented by I. C. Greene, '94, Charles A. Norton (1897).

RELIGIOUS SERVICES.

Students are required to attend prayers every week-day at 8 A.M., and public worship in the chapel every Sunday at 10.30 A.M. Further opportunities for moral and religious culture are afforded by a Bible class taught by one of the professors during the hour preceding the Sunday morning service and by religious meetings held on Sunday afternoon and during the week, under the auspices of the College Young Men's Christian Association.

LOCATION.

Amherst is on the New London Northern Railroad, connecting at Palmer with the Boston & Albany Railroad, and at Miller's Falls with the Fitchburg Railroad. It is also on the Central Massachusetts Railroad, connecting at Northampton with the Connecticut River Railroad and with the New Haven & Northampton Railroad.

The college buildings are on a healthful site, commanding one of the finest views in New England. The large farm of three hundred and eighty-three acres, with its varied surface and native forests, gives the student the freedom and quiet of a country home.

APPENDIX.

The Crambidæ of North America.

C. H. Fernald, A.M., Ph.D.

January, 1896.

THE CRAMBIDÆ OF NORTH AMERICA.

The insects included in the family *Crambidœ* are, so far as known, injurious to the grasses (*Gramineœ*), some living in tubular habitations which they construct near the roots, others boring into the stems of the plants on which they feed, while a few occasionally feed on plants of other families.

Distribution.

The species of this family are distributed very widely over the globe, but apparently are most numerous in the temperate zones. They are well represented in Europe and North America, and even Australia and New Zealand have a comparatively large number of species.

Injuries.

These insects feed at the roots of the grasses, and are therefore often overlooked, except where they are so abundant as to seriously injure the crops. They undoubtedly destroy a large amount of grass without being discovered, the injury being attributed to some other cause. Prof. F. M. Webster, entomologist to the Ohio Agricultural Experiment Station, wrote me, Dec. 12, 1895, that the larvæ of some species of *Crambus*, probably *trisectus* and *laqueatellus*, during May of that year were the most abundant and destructive that he had ever known them to be in the West; hundreds of acres of both corn and oats, which had been planted on spring-ploughed meadow or pasture lands, were as completely swept out of existence as if burned over, and the damage done by these insects would probably amount to several hundred thousand dollars. Professor Webster also

wrote that, a few years ago, the larvæ of *Crambus vulgivagellus* ravaged the corn fields of Ashtabula County, Ohio.

In 1881, the larvæ of *Crambus vulgivagellus* devastated the fields of several counties in northern New York, and were very abundant in many other places during that year. In 1892, the larvæ of *Crambus caliginosellus* were reported as doing great damage to corn in Delaware and Maryland, and it is a common thing to receive these moths from the farmers in various parts of the country, stating that they are more or less abundant.

Natural Enemies.

Professor Lintner bred a Hymenopterous and a Dipterous parasite from these insects, and also found the predaceous beetle, *Calosoma calidum* (Fab.), destroying them, as he believed. Professor Riley also bred two different Hymenopterous parasites from the larvæ of *C. laqueatellus*. Insectivorous birds are known to feed freely upon these moths. Professor Webster states, on the authority of J. N. Latta of Haw Patch, Ind., that the moths of *Crambus laqueatellus* were destroyed in great numbers by the wood pewee (*Contopus virens*), and I have myself observed barn swallows feeding on different species of *Crambus* in abundance in Maine. When walking through the grass, at my home on Mt. Desert, the *Crambids* were "flushed," and several swallows invariably attended us, snapping up the moths as they flew. Whenever we stopped the swallows would leave; and as soon as we started, they would return to catch the moths, often flying within a few feet of us. These observations were made during several years, and led me to conclude that farmers would do well to afford every possible encouragement to these birds to nest in their barns, for they do a vast amount of good in destroying injurious insects while on the wing.

History.

The species of this family were placed by Linnæus, in all his writings, under his genus *Tinea*. The authors of the "Systematisches Verzeichniss der Schmetterlinge der Wienergegend," published in 1776, placed them under the *Tineæ*,

in the division of *Tineæ Directipalpes.* Hübner, in his "Sammlung europäischer Schmetterlinge," figures the European species under the genus *Tinea.* A part of the plates on which these species are represented were published in 1796. Fabricius, in the supplement to his "Entomologia Systematica," p. 464, published Feb. 10, 1798, established the genus *Crambus* with sixty-two species under it, some of which do not belong to this genus and they have since been removed to other genera. Fabricius did not mention any species as the type of the genus. In Vol. III., part II., of this work, published in 1794, on p. 238, he described the species *saccharalis;* and, so far as I can learn, this was the first species of the family published from this country. Latreille, in his "Histoire Naturelle des Crustaces et Insects," Vol. XIV., p. 247, 1805, adopts the generic name *Crambus*, and places under it *carnella* L., *pinellus* L., *culmellus* L. and *pascuellus* L. The last three are still retained in the genus *Crambus.*

In 1811, Haworth published part III. of his "Lepidoptera Britannica," in which he established the genus *Palparia* for the species usually placed under *Crambus.* He had previously, in part II. of the same work, used the genus *Crambus*, but, strange to say, he had none of the species now regarded as *Crambids* under it. Leach, in the article "Entomology" in the "New Edinburgh Encyclopædia," published in 1815, adopted the generic name *Crambus*, with *pineti*, *pascuorum* and *pratorum* under it, and placed it as the second genus in his family *Tineida.* In 1817, Zincken, in Germar's "Magazin der Entomologie," Vol. II., published his monograph of the genus *Chilo*, with *phragmitellus* Hüb. as the first species under it, and this has been taken as the type of *Chilo.* Zincken included in his genus most of the species now retained under *Crambus.* In Vol. III., p. 114, 1818, Zincken described *C. leachellus*, the habitat of which was unknown, but it has since proved to be a well-known North American species; and in Vol. IV., p. 247, 1821, *C. sordidellus*, *satrapellus*, *præfectellus*, *decorellus*, *plejadellus*, *teterrellus* and *incertellus* from South Carolina, and *C. haytiellus* from the Island of San Domingo, but I have received this last species both from San Domingo and

Texas. Hübner, in his "Verzeichniss bekannter Schmetterlinge," did not adopt the generic name *Crambus*, but placed the species of the *Crambidæ* under several genera, as follows: *Argyroteuchia*, with ten species; *Eucarphia*, with *radiellus*, *fulgidellus* and *vinetella* under it. (The first two belong to the genus *Crambus*, but the last belongs to the *Phycitinæ*, and has been left as the type of *Eucarphia*.) *Catoptria*, with six species; *Agriphila*, with five species; *Pediasia*, with seven species; *Topeutis*, with ten species; *Eromene*, with one species, *bella*; *Chrysoteuchia*, with two species; *Thisanotia*, with three species; and *Exoria*, with three species. This part of Hübner's "Verzeichniss" was published not earlier than 1822. In 1825, Curtis, in his "British Entomology," Vol. III., p. 109, adopted *pascuellus* L. as the type of the genus *Crambus*. I am not aware that any one, previous to this time, specified any one of the species as the type, and therefore, in accordance with the rules of zoölogical nomenclature, this species may be regarded as such.

Stephens, in his "Illustrations of British Entomology, Haustellata," Vol. IV., p. 317, 1834, adopted the generic name *Crambus*, with thirty-eight species, but placed it in his family Tineidæ. In 1836, Duponchel published the tenth volume of "Histoire Naturelle des Lepidopteres," in which he adopted the genus *Chilo*, with *phragmitellus* under it, and *Crambus*, with many species that properly belong there, and some others that have since been placed elsewhere. In 1840, Zetterstedt, in his "Insecta Lapponica," adopted the genus *Chilo* for the species now usually placed in the *Crambidæ*, and placed it in his family *Tinearice*, thus following the plan of Zincken.

In Vol. IX., part II., of "Die Schmetterlinge von Europa," published in 1832, Treitschke adopted the genus *Chilo*, and placed *gigantellus* Fab., with forty-three other species, under it. In 1849, Herrich-Schäffer published the fourth volume of his "Schmetterlinge von Europa," in which he established the group *Crambides*, in which he placed all the *Pyralids*, including the genera *Chilo*, *Crambus* and *Ancylolomia*.

In 1858, Christoph, in the "Stett. Ent. Zeit.," Vol. XIX., p. 313, described two species of *Crambus* from Labrador.

In 1860, Clemens described twelve species under the genus *Crambus*, in the "Proceedings of the Academy of Natural Sciences of Philadelphia," one of which, *auratellus*, belongs in the genus *Argyria*. In the same paper he published three species and placed them under the genus *Chilo*, but they did not belong there, and have been more correctly placed under the genus *Schœnobius*, which is not now regarded as belonging to the *Crambidæ*. In 1863, Walker, in his "Cat. Lep. Het.," part XXXVII., adopted the family name *Crambidæ*, with *Chilo*, *Crambus* and several other genera under it. Several North American species were described for the first time in this work, and some others were re-described. In a few cases the descriptions were made from very poor specimens, and it is not only impossible to determine the insects from his description, but very difficult to decide what they are from the types. In 1863, Zeller published a valuable work entitled "Chilonidarum et Crambidarum genera et species," in which he dealt with all the described species, and published many new ones from North America, as well as elsewhere. This work, although appearing in the same year as Walker's, was not published till July, while Walker's catalogue was published in April.

In 1866, Packard described two species of *Crambus* from Labrador, in the "Proceedings of the Boston Society of Natural History." Grote published several species, with a list, in the "Canadian Entomologist," in 1880; and Hulst described several species in the "Transactions of the American Entomological Society," in 1886.

In 1894, Felt published a paper "On Certain Grass-eating Insects," which deserves more than a passing notice. In this paper, for the first time, a special study was made of the early stages of a large number of our species, including their habitations, etc. There is still much to be done in this direction, and it is sincerely to be hoped that the work, so well begun by Mr. Felt, may be continued till we have a complete history of all our species of this family. I should mention, in this connection, the work done by Forbes on the early stages of *zeellus*, by Howard on *saccharalis*, by Miss Murtfeldt on *teterrellus* and by Scudder on *hortuellus*.

External Anatomy.

The following studies were made on *Crambus laqueatellus* with occasional references to the other species. The head (Plate A, figs. 1 and 2) is of moderate size, and connected with the thorax by a small neck. The compound eyes (Plate A, figs. 1–4, *e*) are large and hemispherical, varying somewhat in outline in the different species. The ocelli (Plate A, figs. 1–3, *o*), situated behind and near the base of the antennæ, are present in most of these insects. The antennæ (Plate B, figs. 15–17) have from fifty to fifty-five segments in *C. laqueatellus*, the basal segment being much larger than the others; the first two are covered with scales and the others with two scale clusters each, on the upper side, while fine hairs are scattered over the remaining surface (Plate A, fig. 9, and Plate B, figs. 15–17). All except a few of the basal joints have several sense pits on each side (generally four in the male and three in the female). These sense pits are circular in outline, guarded by a row of hairs which arise obliquely from the edge, and are located somewhat irregularly on the joints. Under a high magnifying power the antennal segments appear to have a reticulated surface (Plate A, fig. 10).

The epicranium is separated from the clypeus by a well-marked transverse suture just in front of the base of the antennæ. The clypeus is large and convex (Plate A, fig. 3); in some species it is more or less swollen in the middle, while in others it is produced in the form of a cone. The cheeks occupy the lower and lateral portions of the face. The small, somewhat triangular lábrum is in front of the clypeus and over the base of the tongue. The mandibles are rudimentary, and armed with bristles which extend inward and rest on the base of the tongue. The maxillæ are developed into a sucking tube, which is called the proboscis or tongue. This organ varies in length, to some extent, in the different species, and is covered with scales at the basal part. When not in use it is coiled up, like a watch-spring, between the labial palpi, and concealed by them. The labial palpi have three segments, extended horizontally forward and thickly covered with scales. They vary greatly in length in the different species (Plate A, figs. 1, 2 and 3;

Plate C, figs. 1, 4, 10, 12 and 16). The maxillary palpi have three segments extending forward nearly horizontally and resting on the base of the labial palpi. They are densely scaled, and at the outer end the scales form a triangle.

Curtis figures the structural characters of what he calls *Tinea paleella* Hüb. on Plate 109 of his "British Entomology," together with *Crambus radiellus* Hüb., and represents the maxillary palpus of *paleella* with four segments arising from the side of the tongue. Felt, in his excellent work on *Crambus*, gives a figure of the maxillary palpus of *C. agitatellus*, with four joints.

The above studies were made on dry specimens, and a fourth segment could not be found. Whether it is visible in fresh specimens, I am not able to say. The maxillary palpi in dry specimens of *C. laqueatellus* certainly do not arise from the side of the base of the tongue, unless, in drying, the tissues about the mouth-parts have so shrunken as to draw them far out on the sides, as shown on Plate A, fig. 3. Mr. Felt does not indicate the origin of the maxillary palpi in his work.

The prothorax is very small, and the upper side is divided into two parts. Scudder has given the name of prothoracic lobes to similar structures in the butterflies. The mesoscuta are large, and extend far back on each side of the large mesoscutellum. The metascuta are much smaller than the mesoscuta, and are followed behind by the metascutellum. On the forward edge of the metascutum there is an area (Plate A, figs. 1 and 2) without scales or hairs, but covered with minute spines directed forward. This corresponds to a similar spiny area on the under side of the fore wing. The abdomen consists of eight segments. The genitalia of the male are often retracted to such an extent that they are not visible beyond the end of the eighth segment. No figures of these organs are given here, as Mr. Felt has already given most excellent figures of the genitalia of twenty-six different species of *Crambus*.

The legs (Plate A, figs. 5, 7 and 8) are of medium length and size, and consist of the coxa, which is comparatively long and stout; the trochanter, which is of medium size; the femur, which is of medium size and length, the middle

femur being the longest; the tibia, which is rather slim; and the tarsus, consisting of five segments, the last of which terminates in a pair of claws. There is a tibial epiphysis near the end of the fore tibia (Plate A, figs. 5 and 6), which is armed with bristles on the inner side. The tibia of the middle leg has a pair of spurs at the end, the outer of which is about two-thirds as long as the inner, and the hind tibia has a pair at the end and a similar pair at the outer third.

The fore wings are long and narrow in most of the species, while the hind wings are broad. I have adopted in this work the old system of numbering the veins, at the risk of being considered behind the times, for the reason that, notwithstanding we have recently been given several systems or modifications of nomenclature by authors in whom I have great confidence, I must confess that as yet I am undecided which one should be taken. The old system of venation of Herrich-Schäffer is shown in the wings of *Crambus pascuellus* (Plate B, figs. 1 and 2). The cell in the fore wings is closed, but in the hind wings it is closed in some species and open in others. The frenulum of the hind wing is single in both sexes, though there is an indication at the base that it is composed of several bristles fused together (Plate B, fig. 13, male, fig. 14, female).

The veins terminate at the margins of the wings in a rather indefinite way, but at a short distance from the end there are two circular spots on each vein, with short irregular lines radiating from them (Plate A, fig. 11). There is a row of peculiar spines around the outer margin, which are placed at equal distances from each other and arise very near the edge of the wing (Plate A, fig. 11, *s*). Near the base of the hind margin of the fore wing, on the under side, is a small, oval, spiny area (Plate B, fig. 11). There are no scales on this area, but it is covered with short, sharp spines, which point toward the outer end of the wing. A portion of this area, with a few of the adjacent scales, is shown on Plate B, fig. 12. This area is so placed that when the wings are closed it rests upon the similar area on the side of the metascutum, already mentioned, and the spines on the two areas then point in opposite directions. My assistant, Mr. R. A. Cooley, a most careful and pains-

taking student of entomology, first discovered these spiny areas on the wings of the gypsy moth, and has since found them in a large number of our moths and also on the *Trichoptera*. In the butterflies, however, Mr. Cooley finds the scales modified in this place to such an extent that they are intermediate between spines and scales; but in the *Pterophoridæ* there are no spiny areas. So far as he has carried his studies, it would seem that they are present in those insects which close the wings in such a manner that the under side of the basal part of the hind margin of the fore wing rests on the side of the thorax; but in those insects which do not hold the wings in this manner they do not occur, or, if present, are in a modified form. Mr. Cooley will soon publish the result of his studies.

After Mr. Cooley had found the spiny area in the fore wing of the gypsy moth, I learned that Donitz had previously discovered a similar area in the fore wing of *Dionychopus niveus* Men. of Siberia; but he claims to have found its counterpart on the hind wing, and considers it a musical apparatus. I do not know how *Dionychopus* holds its wings when at rest, and cannot express any opinion as to the accuracy of the observations and conclusions of Donitz; but I am inclined to think that the insects observed by Mr. Cooley use this apparatus for an entirely different purpose.

Family CRAMBIDÆ.

The moths included in this family are medium or rather small in size, generally of light colors. Brown, yellow and white prevail, and many of them have metallic markings on the fore wings, which are comparatively long, and in some cases narrow. These are rolled around the body when the insect is at rest, and conceal the large hind wings, which are folded beneath.

The ocelli are present in most of the species. The labial palpi are porrect, nearly straight and often long, sometimes as long as the head and thorax; the maxillary palpi are well developed and strongly triangular. The fore wings have veins 4 and 5 arising near each other, or sometimes from a stalk; 8 and 9 stalked or sometimes fused, forming a single

vein; 7 sometimes arises from the stalk of 8 and 9; 11 from beyond the middle of the cell. Hind wings, on the upper side, with a row of long hairs on the hind margin of the basal part of the cell; veins 4 and 5 stalked, or united throughout as one vein; 7 arises from 6, near its origin, anastomosing with 8.

These insects usually fly near sunset, but may be "flushed" at any time during the day. The eggs are more or less melon-shaped, ribbed and reticulated, or smooth. Larva smooth, with few hairs, feeding in silk-lined galleries on the grass family, or boring in stems. Pupa formed in a cocoon within the galleries.

Synopsis of the Genera.

1.	Outer margin of fore wing with one indentation, . . .	2.
	Outer margin of fore wing without indentations, . . .	4.
2.	Hind wings with eight veins, ...	*Eugrotea.*
	Hind wings with seven veins, ...	3.
3.	Fore wings more than three times as long as wide,	*Pseudoschœnobius,*
	Fore wings less than three times as long as wide, .	*Prionapteryx.*
4.	Hind wings with seven veins, ...	*Uinta.*
	Hind wings with eight veins, ...	5.
5.	Fore wings with veins 7, 8 and 9 arising from one stalk, .	6.
	Fore wings with vein 7 separate from the stalk of 8 and 9, .	7.
6.	Antennæ of the male pectinate, ...	*Thaumatopsis.*
	Antennæ of the male not pectinate, ...	*Crambus.*
7.	Ocelli present, ...	8.
	Ocelli absent, ...	*Diatræa.*
8.	Fore wings three times as long as wide, . . .	*Euchromius.*
	Fore wings not more than twice as long as wide, ...	9.
9.	Fore wings white, with yellow markings, ...	*Argyria.*
	Fore wings yellow or brown, ...	*Chilo.*

Uinta Hulst.

Head medium; front smooth and vertical; eyes large and hemispherical; ocelli present; antennæ coarsely ciliated, and toothed near the base; labial palpi porrect, about three times as long as the head, and coarsely scaled; maxillary palpi about as long as the head, quite bushy and triangular; tongue rudi-

mentary, scaled at the base. Fore wings with ten veins; 4 and 5 coalesce so as to appear as one; 7 arises from the stem of 8 and 9; 10 and 11 coalesce, forming one vein. Hind wings with a distinct pecten of hairs on the basal part of the median vein on the upper side; seven veins; 4 and 5 coalesce, forming but one vein.

This genus was established by Rev. Geo. D. Hulst in "Entomologica Americana," Vol. IV., p. 116, 1888.

Uinta oreadella Hulst. (Plate VI., fig. 14.)

Expanse of wings, 15 mm. (about three-fifths of an inch). Head and palpi very dark gray; thorax blackish gray. Fore wings dark fuscous, darker at the base; basal line wanting; outer line broad, dark brown; terminal line also dark brown, and a dark-brown dot occurs near the middle of the wing. Hind wings fuscous.

Only a single example of this species is at present known, and that is in the collection of the Rev. G. D. Hulst, who received it from Colorado, and published the description of it in "Entomologica Americana," Vol. IV., p. 116, 1888. I am under obligations to Mr. Hulst for the loan of this and other insects from which to make the drawings that appear in this work. Nothing is known of the early stages and habits of this rare insect.

PRIONAPTERYX Stephens.

Head medium, face slightly cone-shaped; eyes large, nearly hemispherical; ocelli absent; antennæ serrate in the male, simple in the female, nearly two-thirds as long as the costa; labial palpi porrect, about twice as long as the head and coarsely scaled at the end; maxillary palpi triangular, half as long as the labial palpi, and resting on them; tongue well developed; thorax and abdomen smooth. Fore wings with twelve veins, 6 and 7 from one point or stalked, 11 and 12 approach very near or join near the middle of 11, after which they run separately to the costa; outer margin notched near the end of vein 5. This genus was established by Stephens for a mutilated example of an insect which he described under the name of *nebulifera*, and of which he says: "Of this sin-

gularly remarkable insect I have seen only my own specimen, which I obtained from the collection of Mr. Haworth, who appears to have procured it from that of Mr. Francillon; I know not its locality." The type is in the Stephens collection in the British Museum, and shows very plainly the mutilation in the costa of the fore wings, which he describes as "three or four deep serratures towards the apex." It is our well-known North American species by that name, and the type was undoubtedly from this country.

PRIONAPTERYX NEBULIFERA. (Plate VI., fig. 1.)

Prionapteryx nebulifera Steph., Ill. Br. Ent. Haust., Vol. IV., p. 317 (1834).
Prionapteryx nebulifera Wood, Ind. Ent., p. 214, Plate XLVII., fig. 1484 (1854).
Prionopteryx nebulifera Zell., Chil. et Cram., p. 18 (1863).

Expanse of wings, 22–31 mm. Palpi, head and thorax ashy brown. Fore wings brown, with a short oblique white streak on the middle of the costa and two broader spots before the apex; an irregular quadrate white spot before the middle of the wing, extending from the hind margin across the cell; two parallel white stripes within the outer margin, within which is a large white spot with several dashes of brown upon it. Fringes cream-white, marked with two or three streaks of brown below the apex. Hind wings pale fuscous, whitish at base.

Habitat. — Texas. Early stages and food plant unknown.

PRIONAPTERYX ACHATINA. (Plate VI., figs. 2 and 3.)

Prionopteryx achatina Zell., Chil. et Cram., p. 13 (1863).
Crambus delectalis Hulst, Tr. Am. Ent. Soc., Vol. XIII., p. 165 (1886).

Expanse of wings, 22–25 mm. Palpi, head and thorax sordid white, dusted over with cinnamon-brown scales. Fore wings white, dusted over with cinnamon-brown scales, except on the two cross-lines; the inner one near the middle of the wing with two outward angles, the outer one somewhat arcuate. The brown scales are more numerous within

and on the outside of the outer line; those on the hind part are very much darker brown, forming an ill-defined dark spot, a similar spot between this and the base of the wing. The terminal portion of the wing white, with two dark-brown horizontal dashes and more or less light brown above the middle. Hind wings pale fuscous, paler basally.

Habitat. — Texas, Arizona. Early stages and food plant unknown.

I have carefully examined the types of Zeller and Hulst.

PRIONAPTERYX CUNEOLALIS. (Plate VI., fig. 4.)

Crambus cuneolalis Hulst, Tr. Am. Ent. Soc., Vol XIII., p. 166 (1886).

Expanse of wings, 19–22 mm. Palpi, head and thorax sordid white, dusted over with cinnamon-brown scales, darkest on the palpi. Fore wings white, dusted over with brown scales, but leaving cross-lines; the inner one, near the middle of the wing, edged outwardly with brown, has two angles; the outer one, angulate beyond the cell, and edged with brown on the inside. The terminal space white near the apex and also in the middle, which is crossed by four dark dashes. Fringe interlined, dark brown and white at the apex and fuscous behind. Hind wings pale fuscous, paler basally.

Habitat. — Texas. Early stages and food plant unknown.

PRIONAPTERYX INCERTELLA.

Chilo incertella Zinck., Germ. Mag., Vol. IV., p. 253 (1821).
Prionopteryx incertella Zell, Chil. et Cram., p. 14 (1863).
Prionopteryx incertella Robs., Ann. Lyc. N. H. of N. Y., Vol. IX., p. 311 (1869).
Prionopteryx olivella Grote, Bull. U. S. Geo. Sur., Vol. VI., p. 274 (1881).

Expanse of wings, 19–25 mm. Palpi, head, thorax and fore wings olive fuscous, the olive tint more apparent in fresh specimens. The fore wings have a pale shade along the submedian fold from the base outwardly; a pale-yellow or whitish mark on the middle of the costa, and a larger one beyond it at the outer third; an outwardly curved line from

the costa to near the middle of the outer margin. Subterminal line pale, bent outwardly above the median fold and running inwardly below it to the hind margin, just within the anal angle, dentate through the latter part of its course; a fuscous blotch on the hind margin at the basal fourth, and another at the middle, which borders outwardly a very fine angulated line connecting with the first costal mark. The terminal line fine, occurring only on the hind part of the outer border. Fringes pale at base, fuscous outwardly. Hind wings pale fuscous.

Habitat.—North Carolina, Georgia, Illinois. Early stages and food plant unknown.

I have carefully examined the types of Zeller and Grote.

EUGROTEA n. gen.

Head medium; face cone-shaped; eyes hemispherical; ocelli present; antennæ simple in the female, male not seen; labial palpi porrect, about three times as long as the head, coarsely haired; maxillary palpi triangularly scaled, about twice as long as the head; tongue well developed; thorax and abdomen smooth; legs of medium length and size; inner spurs one-third longer than the outer. Fore wings two and one-half times as long as wide, with twelve veins; 4 and 5 on a long stalk, 7, 8 and 9 from one stalk; the outer margin notched at the end of vein 4. Hind wings one and a half times as long as wide, with eight veins; 4 and 5 from a long stalk; cell closed.

I have named this genus in honor of my old friend, Prof. A. R. Grote, who years ago advised me to take up the study of the North American microlepidoptera, and has ever since taken a lively interest in my work.

Eugrotea dentella n. sp. (Plate VI., fig. 5.)

Expanse of wings, 25 mm. Head, thorax and palpi white, heavily sprinkled with dark-brown scales. Fore wings white, marked with dark brown (olivaceous in certain lights) on the basal half of the costa down to the cell; on the basal third of the hind margin, a more or less zigzag or dentate cross-stripe a little beyond the middle, a second irregular cross-stripe

between the last and the outer margin, one or two oblique stripes near the apex and the terminal line, are all brown. There are also more or less brown scales sprinkled over the white portions of the wing. In this respect there is a great deal of variation. Fringes pale at the base, fuscous outwardly. Hind wings pale fuscous, with finely interlined fringes.

Habitat. — Florida. Early stages and food plant unknown.

PSEUDOSCHŒNOBIUS N. GEN.

Head medium; face cone-shaped; eyes hemispherical; ocelli present; antennæ (Plate B, fig. 16) finely toothed and ciliate, about two-thirds the length of the costa; labial palpi porrect, about three times the length of the head; maxillary palpi triangular, about as long as the head; tongue rudimentary; thorax smooth; legs long and slim, all the inner spurs twice as long as the outer; abdomen long and slim.

Fore wings (Plate C, fig. 8) three and a half times as long as wide; outer margin falcate and apex rounded; eleven veins, 4 and 5 from one point, 6 and 7 from a short stem, 8 and 9 from one stem; 11 arises from the outer third of the cell and runs into 12, fusing with it from the point of junction to the costa; 1 *a* is nearly half as long as the wing; 1 *b* is simple at the base. Hind wings (Plate C, fig. 9) triangular, not quite twice as long as wide; veins 4 and 5 coalesce, forming but one vein, 6 remote from 7; median vein above pectinated basally. This genus was first proposed in Smith's "List of the Lepidoptera," 1891, for *opalescalis*, a species described by Hulst, from Arizona, and placed under *Schœnobius*; but, as the structure of the insect gave it no abiding place in any genus already established, we have now characterized this new genus for it.

Pseudoschœnobius opalescalis. (Plate VI., fig. 13.)

Schœnobius opalescalis Hulst, Trans. Am. Ent. Soc Vol. XIII., p. 167 (1886).

Expanse of wings, 29 mm. Palpi dark fuscous, cinereous above; head and thorax cinereous, the tegulæ edged with white; abdomen fuscous, annulate with cinereous; fore wings cinereous, with white scales scattered profusely between the veins; fringe of the same color as the wings. Hind wings above and beneath light fuscous, somewhat opalescent. Under side of fore wings fuscous, paler towards the apex. Described from six examples in my collection, from Arizona; one in the collection of the National Museum, from the Argus Mountains, Cal.; and the type in the collection of Mr. Hulst.

CRAMBUS Fabricius.

Head medium; face rounded, more or less swollen or cone-shaped; eyes more or less hemispherical; ocelli present; antennæ about two-thirds as long as the costa, dentate or ciliate in the male (Plate B, fig. 17), simple in the female (Plate A, fig. 9); labial palpi very long, porrect; maxillary palpi moderately long, porrect, triangularly dilated with scales (Plate C, fig. 16); tongue well developed; thorax smooth; abdomen of the male with a small anal tuft.

Fore wings from two to three times as long as wide, with twelve veins; 4 and 5 sometimes from a stalk; 7, 8 and 9 from a common stalk; 11 bent more or less and sometimes connected with 12. Hind wings about one and one-half times as long as wide; veins 4 and 5 from one point or from a stalk.

This genus contains by far the largest number and the most common of our species. From the studies of Riley, Lintner, Forbes, Felt, Beckwith and Miss Murtfeldt, we know something of the early stages of a large number of our species.

Synopsis of the Species.

1. Fore wings with ground color whitish, ... 2.
   Fore wings with ground color ochreous, brown or gray, . 6.
2. Fore wings without markings or terminal dots, . . . *perlellus.*
   Fore wings with markings or terminal dots, ... 3.
3. Fore wings with a longitudinal reddish stripe near the middle, *girardellus.*
   Fore wings with a terminal and a subterminal row of black dots, ... *turbatellus.*
   Without these characters, ... 4.
4. Subterminal line slightly curved, ... *elegans.*
   Subterminal line strongly angulated, ... 5.
5. Median line widest on the hind margin, . . . *pusionellus.*
   Median line not reaching the hind margin, . . . *albellus.*
6. Fore wings with a white stripe from base to middle or beyond, ... 7.
   Fore wings without such stripe, ... 28.
7. The median white stripe wide and crossed by two oblique bars, ... 8.
   The median white stripe not crossed by two oblique bars, . 9.
8. The inner bar on the middle of the wing, . . . *myellus.*
   The inner bar beyond the middle of the wing, . *luctiferellus.*
9. Median stripe extended to terminal line, but divided outwardly, ... *dimidiatellus.*
   Median stripe extended undivided to terminal line, *unistriatellus.*
   Median stripe not reaching terminal line, ... 10.
10. Stripe divided into costal and subcostal stripes, . . . 11.
    Stripe not divided, ... 15.
11. Hind wings pure white, ... *multilineëllus.*
    Hind wings not pure white, ... 12.
12. Apex of fore wing strongly acuminate, . . . *minimellus.*
    Apex of fore wing not strongly acuminate, ... 13.
13. Terminal dots preceded by black lines, . . . *laqueatellus.*
    Terminal dots not preceded by black lines, ... 14.
14. Outer border notched on vein 6, ... *dumetellus.*
    Outer border straight or nearly so, . . . *agitatellus.*
15. Median stripe with a tooth near middle of costal edge, *carpenterellus.*
    Median stripe without a costal tooth, ... 16.

16. { Hind margin of fore wings more or less white, . . . 17.
    { Hind margin of fore wings not marked with white, . . 19.

17. { Hind marginal streak entire, ... *pascuellus.*
    { Hind marginal streak interrupted, ... 18.

18. { Fore wings bright brown, ... *dissectus.*
    { Fore wings dark brown, ... *labradoriensis.*

19. { Apex strongly acuminate; tooth of stripe long, . *satrapellus.*
    { Apex not strongly acuminate; tooth not long, . . . 20.

20. { Hind wings pure white, ... 21.
    { Hind wings not pure white, ... 24.

21. { White stripe short and wide, with the tooth near the end, *bidens.*
    { White stripe with tooth small and near the middle, . . 22.

22. { Apex acuminate, ... *hastiferellus.*
    { Apex not acuminate; slightly emarginate, ... 23.

23. { White stripe wide, very near the costa, . . . *leachellus.*
    { White stripe narrower; more remote from costa, . *præfectellus.*

24. { White stripe narrower than the costal border, . *argillaceëllus.*
    { White stripe wider than the costal border, ... 25.

25. { White stripe more than two-thirds as long as the wing, . 26.
    { White stripe not more than two-thirds as long as the wing, *alboclavellus.*

26. { Under side of cell marked with black, ... *occidentalis.*
    { Under side of cell not marked with black, ... 27.

27. { Fore wings ochreous cinereous, ... *cypridalis.*
    { Fore wings brown, ... *hamellus.*

28. { Terminal line present above, with three or four dots below, 29.
    { Terminal row of three or four dots below and none above, . 30.
    { Terminal row of seven dots, ... 31.
    { Terminal line more or less indistinct, ... 44.

29. { Outer margin falcate, ... *gausapalis.*
    { Outer margin not falcate, ... *hortuellus.*

30. { Fringes of fore wings cut with whitish, ... *trisectus.*
    { Fringes of fore wings not cut with whitish, . . *laciniellus.*

31. { Veins in the middle of fore wing whitish, ... 32.
    { Veins in the middle of fore wing not whitish, . . . 33.

32. { Veins of hind portion light, edged with black scales, *coloradellus.*
    { Veins of hind portion light, but not edged with black scales, *bolterellus.*
    { Veins of hind portion not light, ... *albilineëllus.*

33. { Fringes golden yellow, ... 34.
    { Fringes not golden yellow, ... 37.

34.	Without median or subterminal lines,	*vulgivagellus.*
	With cross lines,	35.
35.	Terminal space a brighter yellow than rest of wing,	*decorellus.*
	Terminal space of the same shade as rest of wing,	36.
36.	Subterminal line narrow,	*ruricolellus.*
	Subterminal line broad,	*biothanatalis.*
37.	Several heavy brown stripes between the lines,	*hulstellus.*
	Without brown stripes between the cross lines,	38.
38.	Subterminal line finely dentate,	39.
	Subterminal line not dentate,	40.
39.	Bright yellow along the submedian fold,	*hemiochrellus.*
	Submedian fold not bright yellow,	*mutabilis.*
40.	Subterminal line very near the outer margin,	*attenuatus.*
	Subterminal line not very near the outer margin,	41.
41.	With white lines through the middle,	*haytiellus.*
	Without white lines through the middle,	42.
42.	Top of the head and thorax white,	*teterrellus.*
	Top of the head and thorax not white,	43.
43.	Fore wings reddish brown,	*anceps.*
	Fore wings grayish,	*undatus.*
44.	Dark brown with white median shade and subterminal line,	*trichostomus.*
	Without white median shade,	45.
45.	Median white stripe from base of wing,	*oregonicus.*
	Without median white stripe,	46.
46.	Fore wings with a white point near the end of the cell,	*bonifatellus.*
	Fore wings dark brown,	*caliginosellus.*
	Fore wings ashy gray,	*zeëllus.*
	Fore wings ochreous yellow,	47.
47.	Median and terminal spaces slightly ashy	*ulæ.*
	Median and terminal spaces not ashy,	*luteolellus.*

CRAMBUS SATRAPELLUS. (Plate I., fig. 1.)

Chilo satrapellus Zinck., Germ. Mag., Vol. IV., p. 247 (1821).
Crambus satrapellus Zell., Chil. et Cram., p. 16 (1863).
Crambus aculeilellus Walk., Lep. Het., Vol. XXVII., p. 158 (1863).
Crambus elegantellus Walk., Lep. Het., Vol. XXVII , p. 179 (1863).
Crambus elegantellus Robs., Ann. Lyc. N. Y., Vol. IX., pp. 315, 316 (1869).
Crambus satrapellus Felt, Grass-eating Ins., p. 89 (1894).

Expanse of wings, 25–35 mm. Head and palpi yellowish gray; thorax light golden yellow; labial palpi slender, about the length of the thorax, pale cinereous fuscous on the outside, the under margin whitish. Fore wings much produced at the apex, golden yellow, rust brown on the costa; from the base to near the outer margin a sharply pointed, silvery-white stripe, with a long, acute tooth projecting on the under side, from the middle nearly to the subterminal line. Above its apex, and parallel with it, a small spindle-shaped, silvery-white stripe. Both stripes bordered with rust brown. Subterminal line with a very acute angle near the outer margin, just below the apex. Costal half of apex dark brown, outer marginal half white. Fringes, white next the terminal line, brown outwardly. Hind wings pale cinereous; fringes white. Abdomen and legs grayish white.

Habitat. — Florida, Georgia, Texas. Food plant and early stages unknown.

CRAMBUS HASTIFERELLUS. (Plate I., fig. 4.)

Crambus hastiferellus Walk., Lep. Het., Vol. XXVII., p. 155 (1863).
Crambus quinquareatus Zell., Ex. Mic., p. 38, Plate I, fig. 16 (1877).
Crambus extorralis Hulst, Tr. Am. Ent. Soc., Vol. XIII., p. 165 (1886).

Expanse of wings, 16 mm. Head, palpi and thorax above, golden fuscous; abdomen white with fuscous annulations. Fore wings golden fuscous, darker on the costa nearly to the terminal line. A broad, silvery-white stripe, nearly reaching the costa and basally bordered with a dark line, extends from the base nearly to the subterminal line, taper-

ing bluntly at the tip, which rests upon a cream-colored stripe extending across the line and there uniting with a white sub-apical spot. Subterminal line very oblique in its first third from the costa, then from an obtuse angle it runs straight, with the exception of a small blunt tooth, to the inner margin. Above the dark apical dash, a light triangular spot. Terminal space, below the light stripe, brown with a few dark lines. Below the silvery stripe the wing is lighter in color, with a darker wedge-shaped space on the outer part. Terminal line dark, brownish ochreous. Fringes metallic. Hind wings white.

Habitat. — Nova Scotia, Pennsylvania, Florida, Louisiana, Texas, California. Food plant and early stages unknown.

Crambus occidentalis. (Plate II., fig. 3.)

Crambus occidentalis Grote, Can. Ent., Vol. XII., p. 16 (1880).
Crambus occidentalis Grote, Can. Ent., Vol. XIII., p. 66 (1881).

Expanse of wings, 16 mm. Head, palpi and thorax above, ochreous brown. Fore wings ochreous, heavily dusted with fuscous; the white streak in the costal half of the wing dilated in the middle, with a prominent tooth on the lower side, which is bordered with a heavy, dark-brown shade, especially from the tooth to the base. The subterminal line forms an acute angle under the apical patch. Apex light, with a dark shaded patch in the centre. Five dark-brown venular dots in the terminal space. Hind wings pale fuscous.

Habitat. — California. Food plants and early stages unknown.

It differs from the other species in the prominent notch or tooth at the middle of the lower side of the white stripe, and by the heavy dark shades below the stripe.

Crambus minimellus. (Plate II., fig. 2.)

Crambus minimellus Robs., Ann. Lyc. N. Y., Vol. XI., p. 315 (1869).
Crambus minimellus Felt, Grass-eating Ins., p. 88 (1894).

Expanse of wings, 13–15 mm. Head, palpi and thorax dark shining fuscous. Fore wings glossy fuscous, with a

whitish stripe above the middle of the wing and below two fuscous longitudinal lines on the upper part; this whitish stripe extends from the base nearly to the subterminal line, where it ends acutely in a dark line reaching to the end of the wing. Bordering the acute end of the stripe, above and below, are two small, white, wedge-shaped spots, pointing inwardly. A diamond-shaped, silvery-white spot in the apex of the wing, with a dark streak and lighter patch above it. Median line dark brown, arising from the middle of the costa and sending a very acute angle outward, which encloses the end of the white stripe and gives off two outward and one inward acute angles below the stripe, and ends near the middle of the hind margin. Subterminal line, bordered on each side with white in the first part of its course, arises from the outer fourth of the costa and runs obliquely out beyond the end of the stripe, where it forms a right angle and extends to the hind margin within the anal angle, giving off a tooth inwardly in the middle of its course.

Habitat. — New York, Pennsylvania, Texas, Illinois. Early stages and food plant unknown.

Crambus argillaceëllus. (Plate II., fig. 1.)

Crambus argillaceëllus Pack., Pr. Bos. Soc. N. H., Vol. XI., p. 54 (1866).

Expanse of wings, 16 mm. Head, thorax and outside of the palpi cinereous brown, with a slightly bronzed hue. Fore wings cinereous brown, with a narrow white stripe increasing in width for one-half the length of the wing, when it tapers off acutely on the outer fourth; a brown apical patch on the costa, with a white one below it. Subterminal line forming a right angle at its costal third. Terminal space, below the apical spots, dark; two or three short white parallel lines run from the tip of the white stripe to the subterminal line. Fringes much paler. Hind wings dark, argillaceous above and beneath. Differs from all other species in its peculiar dark hue, especially on the hind wings.

Habitat. — Labrador. Early stages and food plant unknown.

CRAMBUS HAMELLUS. (Plate II., fig. 4.)

Tinea hamellus Thunb., Diss. Ent., p. 97, Plate IV , fig. 3 (1794).
Tinea Ensigerella Hüb., Tinea, Plate LIV., fig. 267 (1803).
Chilo Ensigerellus Zinck., Germ. Mag., Vol. II., p. 53 (1817).
Chilo ensigerellus Tr., Schm., Vol. IX., part 1, p. 79 (1832).
Crambus Ensigerellus Dup., Nat. Hist. Lep., Vol. X., p. 57, Plate CCLXXV. (1836).
Crambus Hamellus H. S., Vol. IV., p. 53 (1849).
Crambus Hamellus Wood, Ind. Ent., p. 215, No. 491 (1854).
Crambus hamellus Staint., Man., Vol. II., p. 181 (1859).
Crambus hamellus Zell., Chil. et Cram., p. 17 (1863).
Crambus Hamellus Hein., Schm., Vol. I., p. 119 (1865).
Crambus hamellus Meyr., Handb. Br. Lep., p. 389 (1895).

Expanse of wings, 20–23 mm. Palpi shining fuscous on the outside ; head ashy brown ; thorax and fore wings brownish cinereous ; a snow-white stripe from the base to a point a little within the subterminal line, giving off a strong tooth near the middle ; costal margin narrow at the base, widening outwardly, and where the white stripe begins to taper the costal stripe is about as wide as the white stripe ; a very small oval streak above the end of the white stripe, sometimes reaching it. Subterminal line brown, bordered with white on each side, at the costa, and edged outwardly with dark lead-colored scales, extending down to a point beyond the end of white stripe, where it forms an obtuse angle, and then crosses the wing in a nearly straight line. Terminal space dark brown with a white triangle reaching to the apex ; below, ashy, with five elongate black spots. Terminal line above, dark brown. Fringes metallic gray, white at base, above. Hind wings pale fuscous ; fringes lighter.

Habitat. — Maine, Europe. Early stages and food plant unknown.

CRAMBUS CYPRIDALIS. (Plate III., fig. 1.)

Crambus cypridalis Hulst, Tr. Am. Ent. Soc., Vol. XIII., p. 165 (1886).

Expanse of wings, 30 mm. Head and palpi cinereous fuscous, whitish above; thorax and abdomen ochreous. Fore wings ochreous fuscous; a silvery-white stripe bordered with a very dark brown line extends from the base nearly to the subterminal line, tapering acutely at the outer end; above this portion another small, tapering white stripe. Terminal line forming a blunt angle at about one-third the width of the wing from the costa. Apex white, with a dark-brown patch. Five fine black lines between the veins in the terminal space. Fringe fuscous, with a white line at the base. Hind wings cream white.

Habitat. — Utah. Early stages and food plant unknown.

CRAMBUS CARPENTERELLUS. (Plate I., fig. 5.)

Crambus carpenterellus Pack., Rep. Hayd. Surv., p. 548 (1873).

Expanse of wings, 28 mm. Head, palpi and thorax tawny ochreous. Fore wings ochreous fuscous, with a white stripe starting from the base and extending to near the subterminal line, where it ends in a point; at the basal third, a tooth on the costal side, and another one at the outer third on the opposite side, which ends in a dark line extending half the distance to the cross-line. Between this line and the point of the streak three other dark lines, parallel to this and gradually growing shorter, arise from the white streak. Below the streak the wing is lighter in color than elsewhere. Subterminal line bordered with white on the costa, slightly curving in its first third, nearly straight the remainder of its course and followed outwardly by a silvery line. Upon the apex a brown triangle with a white triangle above it. A series of five dark-brown marginal dashes. Fringes silvery fuscous. Hind wings much paler.

Habitat. — Mountains of Colorado. Early stages and food plant unknown.

CRAMBUS PASCUELLUS. (Plate I., fig. 3.)

Phalæna Tinea pascuella Linn., Syst. Nat., ed. X, p. 535 (1758).
Tinea pascuella Linn., Faun. Suec., ed. II., p. 355 (1761).
Tinea pascuella Fab., Syst Ent., p. 658 (1775).
Tinea Pascuella Wein. Verz., p. 134 (1776).
Tinea Pascuella Goeze, Ent. Beitr., Vol. III., part 4, p. 85 (1783).
Tinea Pascuella DeVillers, Ent. Linn., Vol. II., p. 460 (1789).
Tinea Pascuella Fab., Ent. Syst., Vol. III., part 2, p. 295 (1793).
Tinea Pascuella Schrank, Faun. Boic., Vol. II., part 2, p. 100 (1802).
Tinea Pascuella Hüb., Tinea, Plate V., fig. 51 (1803).
Chilo Pascuellus Zinck , Germ. Mag., Vol. II., p. 49 (1817).
Chilo pascuellus Tr., Schm., Vol. IX., part 1, p. 75 (1832).
Crambus pascuellus Steph., Ill. Br. Ent. Haust., Vol. IV., p. 320 (1834).
Crambus pascuellus Dup., Nat. Hist. Lep., Vol. X., Plate CCLXIX., fig. 1 (1836).
Crambus Pascuellus H. S., Schm., Vol. IV., p. 53 (1849).
Crambus Pascuellus Wood, Ind. Ent., p. 215 (1854).
Crambus pascuellus Staint, Man., Vol. II, p. 181 (1859).
Crambus pascuellus Zell., Chil. et Cram., p. 20 (1863).
Crambus Pascuellus Hein., Schm., Vol I., p. 120 (1865).
Crambus pascuellus Praun, Tineidæ, Plate I., fig. 15 (1869).
Crambus floridus Zell., Beitr., Vol. I., p. 91 (1875).
Crambus floridus Felt, Grass-eating Ins., pp. 78, 86 (1894).
Crambus pascuellus Meyr., Handb. Br. Ent., p. 390 (1895).

Expanse of wings, 21–24 mm. Palpi fuscous on the outside; head white above; thorax white above and beneath, brownish ochreous on the sides. Fore wings brownish ochreous, with a broad white stripe extending through the wing very near the costa, and ending in an acute angle a short distance within the subterminal line; costal margin brownish fuscous, widening outwardly, but in no place more than half as wide as the white stripe; four or five silvery, black-margined streaks on the outer part of the wing, but not reaching the subterminal line; a white spot beyond and below the end of the white stripe; a white spot on each side of the subterminal line, on the costa. Subterminal line fuscous, arising a little beyond the outer fourth of the costa, extends outwardly to a point beyond the end of the white stripe, where it forms an obtuse angle and crosses the wing to the hind margin. Subterminal space below ashy gray,

with four or five black terminal points. Apex white, triangularly produced, with a terminal dark-brown line, a yellowish-brown costal spot and oblique streak before it. Fringes metallic gray, white at base above. Hind wings whitish, pale fuscous apically; fringes white.

Habitat. — Massachusetts, Texas, California, Europe. Food, grass.

"*Egg.* — Creamy white when first laid, gradually turning to a dark scarlet color before hatching. Form, elliptical oval; size, .39 mm. by .30 mm. The egg-shell has sixteen feeble longitudinal ridges and numerous smaller transverse ridges.

"*Larva, First Stage.* — Head diameter, .21 mm.; body diameter, .15 mm.; length, 1.15 mm. Head black, labrum yellowish, scattered hairs on the head; thoracic shield dark brown; body straw color with fine reddish blotches, giving it a pinkish cast. Scattered hairs grow from small tubercles. When about two weeks old the body is a dark mottled brown When a month old the larva is 1 cm. long." (Felt.)

CRAMBUS GIRARDELLUS. (Plate I., fig. 13.)

Crambus Girardellus Clem., Pr. Ph. Ac. Sci , p. 204 (1860).
Crambus nivihumellus Walk., Lep. Het., Vol. XXVII., p. 159 (1863).
Crambus girardellus Felt, Grass-eating Ins., pp. 73, 86 (1894).

Expanse of wings, 23–25 mm. Labial palpi pale fuscous on the sides, silvery white above and beneath; thorax whitish above, orange-yellow on the sides; abdomen white. Fore wings silvery white, with an orange-yellow stripe, bordered outwardly with dark-brown scales, extending from the base of the wing, beneath the median vein, to beyond the cell, where it turns up toward the apex of the wing. Terminal line brown, edged with yellow, with five short, dark-brown dashes before it on the posterior half of the wing. Hind wings pure white, sometimes smoky on the anterior half.

Habitat. — St. Martin's Falls, Albany River, Hudson's Bay, Ontario, Maine, New Hampshire, Massachusetts, New York, Pennsylvania, Maryland, Ohio. Food, grass.

"*Egg.* — Creamy white when first laid, but gradually changing to bright orange before hatching. Form, elliptical oval; size, .51 mm. by .33 mm. The egg-shell has seventeen longitudinal ridges and numerous smaller transverse ridges.

"*Larva, First Stage.* — Head diameter, .24 mm.; length, 1.05 mm. Head and thoracic shield a glistening black, body a reddish straw color; scattered hairs occur on the head and body; the hairs on the body grow from minute tubercles, which are concolorous with the body. When about a month old the larvæ are 2 cm. long. The head is yellowish, with irregular brown markings; the body is a slate color, with brown tubercles." (Felt.)

Crambus leachellus. (Plate I., fig. 2.)

Chilo Leachellus Zinck., Germ. Mag., Vol. III., p. 114 (1818).
Crambus pulchellus Zell., Chil. et Cram., p. 18 (1863).
Crambus pulchellus Zell., Beitr., p. 89 (1872).
Crambus leachellus Felt, Grass-eating Ins., pp. 71, 85 (1894).

Expanse of wings, 24–30 mm. Head and thorax brassy brown; palpi brownish cinereous. Fore wings golden fuscous, with a broad silvery-white stripe, bordered by a fine dark line, extending outward from the base and ending in a point near the subterminal line; basal stripe narrow, less than half the width of the white stripe at the costa. A very small tooth in the middle on the lower side; a very small, spindle-shaped white spot above the outer end of the white stripe, sometimes connected with it; subterminal line brownish, edged outwardly by a silvery streak, arising from the outer fourth of the costa, forming an angle near the point of the white stripe, thence running straight across the wing and terminating just within the anal angle; from the end of the white streak a pale yellowish stripe extends outward to the terminal line, curving upward to the apex, above which is a brown triangular patch separated from the costa by a small white triangle. Subterminal space below ashy brown, with four or five indistinct black dashes. Terminal line golden fuscous. Fringes grayish metallic, white at base above.

Hind wings white in female, slightly yellowish in the male.

Habitat. — Ontario, Maine, Massachusetts, New York, New Jersey, Pennsylvania, Georgia, Texas, Illinois, California, Vancouver Island, Venezuela, Mendocino.

"*Egg.* — Creamy white in color when first laid, quickly changing to a scarlet and then to an intense geranium red; just before hatching the blackish head of the embryo shows through the thin shell very distinctly. Form nearly oval; size, .51 mm. by .39 mm. The egg-shell is quite fragile, and frequently collapses when the larva leaves it. There are twenty-two longitudinal ridges and numerous smaller transverse ridges. The circular markings around the micropyle are very characteristic.

"*Larva, First Stage.* — Head diameter, .21 mm.; body diameter, .18 mm.; length, 1 mm. Head a brownish black, clypeus yellowish, antennæ nearly colorless; scattered hairs occur on the head; thoracic shield brown, with a reddish tinge from the body contents; body a variable red, the color being the most intense in the thoracic region; there is a slight stigmatal line; tubercles blackish and bearing dark hairs; prolegs almost rudimentary. When about a month old the larvæ are 1.5 cm. long; the head is yellowish, with irregular black markings; the body is brown, with large blackish tubercles. When about six weeks old the larvæ are 3 cm. long and quite stout; the color has not changed." (Felt.)

Crambus unistriatellus. (Plate I., fig. 6.)

Crambus unistriatellus, Pack., Pr. Bos. Soc. N. H., Vol. XI., p. 54 (1866).
Crambus exesus Grote, Can. Ent., Vol. XII., p. 16 (1880).
Crambus exesus Grote, N. A. Ent., Vol. I., p. 68, Plate V., fig. 7 (1880).
Crambus unistriatellus Felt, Grass-eating Ins , p. 85 (1894).

Expanse of wings, 25 mm. Head, palpi and abdomen very pale gray; palpi long, slender, acute; thorax and fore wings golden yellow, with metallic lustre. A broad, uninterrupted silvery-white band on each side, with a few dark scales, extends to the outer edge of the wing, expanding upwards on

the apex; edge of the brown stripe above the silvery band bordered with a few white scales towards the apex. A submarginal row of minute black dots. Fringe concolorous with the rest of the wing. Hind wings white above and beneath. Under side of fore wings and the legs pale gray.

Habitat. — Labrador, Maine, New Hampshire, New York, Pennsylvania, Minnesota, California. Early stages and food plant unknown.

Crambus præfectellus. (Plate I., fig. 7.)

Chilo præfectellus Zinck., Germ. Mag., Vol. IV., p. 248 (1821).
Crambus involutellus Clem., Pr. Ph. Ac. Sci., p. 203 (1860).

Expanse of wings, 21–25 mm. Head, palpi and thorax cinereous with bronze lustre. Fore wings golden fuscous, with a silvery-white stripe bordered with a fine darker line, and tapering toward each end, from the base to near the subterminal line; a tooth in the middle on the lower side; a dark shade, with a light costal triangle above it and a light patch below it, extends from the apex to the subterminal line; costal margin wider than in *leachellus*, being more than one-half the width of the white stripe at the middle of the costa; subterminal space with four dark venular dashes. Fringes grayish metallic, with a white line at the base. Hind wings white or slightly cream colored; fringes white.

Habitat. — Canada, Massachusetts, New York, New Jersey, Colorado, Texas. Early stages and food plant unknown.

Crambus dissectus. (Plate II., fig. 12.)

Crambus dissectus Grote, Can. Ent., Vol. XII., p. 66 (1880).

Expanse of wings, 20 mm. Head and palpi above, white; thorax brown on the sides, white above; abdomen whitish, mottled with brown. Fore wings light brown. A white stripe, very narrow at the base and much dilated in the middle of the wing, where it sends out a long acute tooth behind. The hind margin white, more or less broken. Several very dark-brown parallel dashes run from the white stripe nearly to the subterminal line, and upon these dashes a white, diamond-shaped patch. On the costa, on each side

of the subterminal line, is a white patch. Apex brown, with a white patch below it. Terminal space with a white streak enclosing five very dark-brown dots. Fringes metallic, except at the base of apex. Hind wings smoky fuscous, with pale fringes.

Habitat. — Maine, New York. Early stages and food plant unknown.

Crambus bidens. (Plate I., fig. 8.)

Crambus bidens Zell., Beitr., p. 89 (1872).
Crambus bidens Grote, Can. Ent., Vol. XII., p. 77 (1880).

Expanse of wings, 18 mm. Head and thorax lustrous ochre-yellow; palpi acute, ochre-yellow. Fore wings bright ochre-yellow, with a few rust-brown scales. A few light patches on the inner margin. A very broad silvery-white stripe extends to the costa on one-half the length of the wing, then turns obliquely in a straight line. On the inner side it sends out an acute tooth, then runs in a straight line and meets the costal line at an acute point near the angle of the subterminal line. This line runs obliquely for one-third of its length, then, forming an obtuse angle, runs in a straight line an equal distance, where it forms a very blunt tooth and continues to the inner margin. On the costa a white spot on each side of the subterminal line; also one below the brown apex, and a larger one enclosing five dark-brown dots in the terminal space. Hind wings white, slightly dusted with ochreous.

Habitat. — Massachusetts, New York. Early stages and food plants unknown.

Crambus labradoriensis. (Plate III., fig. 7.)

Crambus Labradoriensis Chris., Stett. Ent. Zeit., Vol. XIX., p. 314 (1858).
Crambus labradoriensis Möschl., Wien. Monats., Vol. IV., p. 379 (1860).
Crambus labradoriensis Zell., Chil. et Cram , p. 21 (1863).
Crambus labradoriensis Pack., Pro. Bos. Soc. N. H., Vol. XI., p. 55 (1866).

Expanse of wings, 18–20 mm. Head and thorax fuscous brownish; lateral margin of the face, palpi above and beneath, at the base, and the apices of the scapulæ, white.

Fore wings slightly emarginate, long and rather narrow, ashy fuscous, mingled outwardly with clay yellow. Median white stripe narrow, remote from the costa, and ending near the middle of the wing in a bidentate apex. Whitish scales in spots and lines between the fuscous spot at the end of the stripe and the subterminal line, which is silvery and extends from the outer fourth of the costa to a point beyond the end of the white stripe, where it forms an obtuse angle and continues in a straight line to the hind margin, within the anal angle. Terminal space white, overlaid more or less, next to the subterminal line, with the ground color of the wing; a dark-brown costal triangle just within the apex. Terminal line dark brown above, followed by fine dark-brown dots. Fringes dark silvery gray. Hind wings fuscous cinereous.

Habitat. — Labrador, Ontario, Oregon. Early stages and food plant unknown.

CRAMBUS DUMETELLUS. (Plate III., fig. 2.)

Tinea Dumetella Hüb., Tineæ, Plate 58, figs. 389, 390 (1803).
Tinea Pratella Hüb., Tineæ, Plate V., fig. 29 (1803).
Argyroteuchia Dumetalis Hüb., Verz., p. 364 (1818).
Agriphila Pratalis Hüb., Verz., p. 365 (1818).
Chilo dumetellus Tr., Schm., Vol. IX., p. 80 (1832).
Crambus Dumetellus Steph., Ill. Br. Ent. Haust., Vol. IV., p. 321 (1834).
Crambus dumetellus Dup. Nat. Hist. Lep., Vol. X., p. 52, Plate CCLXIX. (1836).
Crambus Dumetellus H. S., Schm., Vol. IV., p. 54 (1849).
Crambus Dumetellus Wood, Ind. Ent., p. 215, No. 1493 (1854).
Crambus dumetellus Staint., Man., Vol. II., p. 181 (1859).
Crambus dumetellus Zell., Chil. et Cram., p. 24 (1863).
Crambus Dumetellus Hein., Schm., Vol. I., p. 122 (1865).
Crambus dumetellus Praun, Tineidæ, Plate 1, fig. 16 (1869).
Crambus trichusalis Hulst, Tr. Am. Ent. Soc., Vol. XIII., p. 165 (1886).
Crambus dumetellus Meyr., Handb. Br. Ent., p. 391 (1895).

Expanse of wings, 20–25 mm. Palpi, head and thorax ochreous brown, the palpi somewhat darker on the outside. Fore wings ochreons brown, or dark ochreous brown, with a narrow costal white stripe extending nearly to the middle; a median white stripe extending from the base outward along

the cell, giving off a small tooth near the middle, and cut off more or less obliquely at the outer end, a little below and beyond which is another white streak; subterminal line dark brown, edged outwardly with metallic scales, arising at the outer fourth of the costa, where it is preceded by a white costal spot, and extending to a point beyond the end of the white stripe, then, forming an acute angle, extends with a slight inward curve to the hind margin. Subterminal space below ashy gray, with five more or less distinct terminal black points. Terminal line above dark brown; apical space occupied by two triangles, the lower one white, the upper brown; both separated from the subterminal line by a narrow streak of the ground color of the wing. Fringes silvery fuscous, whitish at the base, emarginate as in *pascuellus*. Hind wings fuscous; fringes lighter.

There are several specimens in the National Museum which are very much darker than any in my possession.

Habitat. — Texas, Colorado, Rocky Mountains, north of Montana (Geddes), Europe. Early stages and food plant unknown.

Crambus gausapalis. (Plate I., fig. 14.)

Crambus gausapalis Hulst, Tr. Am. Ent. Soc., Vol. XIII., p. 167 (1886).

Expanse of wings, 22–24 mm. Palpi light ochreous, darker on the outside; head and thorax ochreous. Fore wings light ochreous, with scattered specks of brown; dark ochreous lines dusted with brown on all the veins beyond the cell; median line ochre-yellow, running obliquely from the middle of the costa about half-way to the apical angle, then, with a sharp angle, back to the cell, where, with another acute angle, it turns toward the outer margin but runs only a short distance. Subterminal line brown, edged outwardly with silvery scales, running evenly from the costa to near the outer margin, where it curves and runs to the hind margin. Terminal space darker, sprinkled with white; terminal line dark brown, replaced below by four dark-brown dots; outer margin falcate, apex acute; apical space light, with a large dark-brown patch on the costa. Fringes golden cinereous, with white at the base above.

Hind wings very pale gray, with a trace of the subterminal line below the apex; fringes lighter.

Habitat. — Sierra Nevada Mountains, California. Early stages and food plant unknown.

CRAMBUS LAQUEATELLUS. (Plate I., fig. 11.)

Crambus laqueatellus Clem., Pr. Ph. Ac. Sci., p. 203 (1860).
Crambus semifusellus Walk., Lep. Het., Vol. XXVII., p. 159 (1863).
Crambus laqueatellus Zell., Chil. et Cram., p. 24 (1863).
Crambus laqueatellus Zell., Beitr., Vol. I., p. 91 (1872).
Crambus laqueatellus Felt, Grass-eating Ins., pp. 79, 89 (1894).

Expanse of wings, 23 mm. Head luteous; thorax and palpi fuscous, the latter whitish beneath. Fore wings ochreous, with two silvery-white streaks separated by a fuscous streak; the outer silvery streak margined on the costa with fuscous; the inner one, which extends beyond the apical third, edged on the fold with fuscous. Beneath the fold the wing is pale yellowish with fuscous streaks along the submedian veins. Apex of the wing tinted with ochreous yellow, the veins streaked with silvery white; on the costa near the tip an oblique silvery streak, margined on both sides with fuscous. The subterminal silvery-white line much angulated, bending in below the apex, leaving a large whitish marginal patch streaked with dark parallel lines which end in dots before the terminal line. Fringes lustrous ochreous. Hind wings pale fuscous; fringes white.

Habitat. — Maine, Massachusetts, New York, Ohio, Illinois, Kentucky, Louisiana, Texas. Food, grass.

"*Egg.* — Creamy white when first laid, gradually turning to an orange color before hatching. Form subcylindrical; size, .42 mm. by .30 mm. There are sixteen longitudinal ridges and numerous smaller transverse ridges.

"*Larva, First Stage.* — Head diameter, .18 mm.; body diameter, .15 mm.; length, 1.15 mm. Head brownish black, with whitish hairs; thoracic shield light brown; body mottled with pale bright red and bearing blackish tubercles." (Felt.)

CRAMBUS ALBOCLAVELLUS. (Plate I., fig. 9.)

Crambus alboclavellus Zell., Chil. et Cram., p. 19 (1863).
Crambus alboclavellus Zell., Beitr., p. 92 (1872).
Crambus alboclavellus Felt, Grass-eating Ins., pp. 77, 88 (1894).

Expanse of wings, 18 mm. Palpi pale fuscous, white beneath; head whitish; thorax luteous. Fore wings brownish luteous, with a broad silvery-white stripe extending beyond the middle on the costa to the cell on the hind side, where it forms a tooth; the two sides then run obliquely and meet at an acute angle, the costal line sending out a tooth before meeting the other; beyond the silvery stripe the dark brown shades off into lighter brown or fuscous, and upon this space rest two white spots, one on the costa and one just before the subterminal line; hind margin much lighter, especially toward the base. Subterminal line brown, edged outwardly with silvery white, very straight to the angle under the apex, where it forms almost a right angle, then runs straight to the hind margin. A row of four or five black marginal points below the apex. Fringes with bronze lustre. Hind wings very pale ochreous, lustrous; fringes whitish.

Habitat. — Massachusetts, New York, New Jersey, Virginia, Ohio, Illinois, Kentucky, Texas, Ontario. Food plant, grass.

"*Egg.* — Creamy white when first laid, gradually turning to an orange-buff color before hatching. Form, elliptical oval; size, .42 mm. by .33 mm. There are about sixteen longitudinal ridges and numerous smaller transverse ridges.

"*Larva, First Stage.* — Head diameter, .225 mm.; body diameter, .14 mm.; length, .625 mm. Head a deep brown, thoracic shield a lighter brown; body a straw color, with a reddish mark along the middle of the back from the fourth to the ninth segments inclusive. Scattered light-colored hairs occur on the head and body." (Felt.)

Crambus agitatellus. (Plate I., fig. 10.)

Crambus agitatellus Clem., Pr. Ph. Ac. Sci., p. 203 (1860).
Crambus saltuellus Zell., Chil. et Cram., p. 22 (1863).
Crambus agitatellus Felt, Grass-eating Ins., p. 88 (1894).

Expanse of wings, 21 mm. Head and thorax pale luteous; labial palpi somewhat fuscous, white beneath. Fore wings ochreous, streaked with orange; a broad silvery-white streak, through which runs a longitudinal yellow stripe; a white patch between the silvery stripe and the subterminal line, another on the costa above it, one on the costa of the apex and another on the outer margin just below the brown apex. A whitish or yellow streak with five venular dots in the terminal space. Subterminal line very oblique in its first third from the costa, then straight to the hind margin. Broken fuscous lines specked with silvery scales along the veins above and beneath the middle of the silvery stripe. Fringes metallic, whitish at base of apex. Hind wings pale cinereous; fringes whitish.

Habitat. — Ontario, Maine, Massachusetts, New York, Illinois, Texas. Early stages and food plant unknown.

Crambus multilineëllus. (Plate I., fig. 12.)

Crambus multilineëllus Fern., Ent. Am., Vol. III., p. 37 (1887).

Expanse of wings, 26 mm. Palpi, head and thorax dull ochre-yellow. Fore wings bright ochre-yellow; a white stripe, extending nearly to the apex, leaving the extreme edge of the costa fuscous; a median white stripe from the base of the wing along the lower part of the cell, out as far as the subterminal line, the outer portion separated by an oblique yellow band. This band, between the two white stripes, edged on each side with a fine line of black and metallic lead-colored scales; similar lines along the intervenular spaces. All the lines terminate just before the subterminal line. Three or four oblique yellow lines, edged outwardly with white, cross the outer part of the costal

white stripe. The subterminal line, overlaid with metallic lead-colored scales, runs down near the outer margin of the wing, where it bends and runs to the hind margin, nearly parallel with the outer margin. A terminal row of five black dots. Fringes pale metallic lead color. Hind wings and fringes white. Abdomen, underside of body and the legs dull ochre-yellow.

Habitat. — Florida. Early stages and food plant unknown.

CRAMBUS ALBELLUS. (Plate III., fig. 5.)

Crambus albellus Clem., Pr. Ph. Ac. Sci., p. 204 (1860).
Crambus albellus Felt, Grass-eating Ins., pp. 76, 88 (1894).

Expanse of wings, 16 mm. Palpi, head, thorax and abdomen pure white. Fore wings white, with a few dark-brown flecks scattered over the hind portion. An oblique, pale-yellow, acutely angulated line from near the middle of the costa to the cell. The strongly angulated outer line silvery white, bordered on each side with yellow. A yellow line from the costa to the terminal line under the apex. A yellow spot on the apical space. Five black marginal dots, with a short blackish line above. Fringe yellow, with golden lustre. Hind wings pale gray or whitish.

"*Egg.* — Creamy white when first laid, gradually turning to pale straw color before hatching. Form, nearly oval; size, .39 mm. by .33 mm. The egg-shell has eighteen longitudinal ridges and numerous smaller transverse ridges.

"*Larva, First Stage.* — Head diameter, .175 mm.; body diameter, .125 mm.; length, .75 mm. General color a smutty white, head darker, and the thoracic shield a little darker than the body. Scattered brown hairs occur on the head; rows of numerous small tubercles occur on the body." (Felt.)

Habitat. — Maine, Massachusetts, New York, New Jersey, Pennsylvania, Canada, Labrador. Food, grass.

Crambus pusionellus. (Plate III., fig. 6.)

Crambus pusionellus Zell., Chil et Cram., p. 16 (1863).
Crambus pusionellus Zell., Stett. Ent. Zeit., Vol. XXXIII., p. 470, Plate II., fig. 3 (1872).
Crambus pusionellus Zell., Exot. Micro., p. 33 (1877).

Expanse of wings, 15 mm. Palpi white, brownish on the outside; head and thorax white. Fore wings lustrous white, with a few scattered brown scales; median line brown, arising from middle of costa, extending out to the end of the cell, thence nearly straight to the hind margin a little beyond the middle, but broken on the fold, gradually dilated in the latter part of its course; subterminal line brown, double, arising from outer fourth of costa, extending outwardly to near the middle of hind margin, then running to outer fourth of hind margin, giving off an inward angle on the fold. A brown spot on the costa, just before the apex, sometimes extended into a streak. Subterminal space more or less stained with brownish. Terminal line dark brown, with three dark-brown dots above the anal angle. Fringes whitish, more or less stained with metallic fuscous. Hind wings and fringes white.

Habitat. — California. Early stages and food plants unknown.

CRAMBUS HORTUELLUS. (Plate II., fig. 11.)

Tinea Hortuella Hüb., Tineæ, p. 29, Plate VII., figs. 45, 46 (1803).
Tinea Cespitella Hüb., Tineæ, p. 29, Plate VII , fig. 45 (1803)
Tinea Falsella Schrank, Faun. Boic., Vol. II., p. 103 (1804).
Chilo Hortuellus Zinck., Germ. Mag., Vol. II., p. 62 (1817).
Chilo hortuellus Tr., Schm., Vol. IX., p. 84 (1832).
Crambus hortuellus Steph., Ill. Br. Ent. Haust., Vol. IV., p. 322 (1834).
Crambus hortuellus Dup., Nat. Hist. Lep., Vol. X., Plate CCLXIX., fig. 1 (1836).
Crambus Hortuellus H. S , Schm., Vol. IV., p. 59 (1849).
Crambus Hortuellus Wood, Ind. Ent., p. 216, No. 1497 (1854).
Crambus hortuellus Staint., Man., Vol. II., p. 182 (1859).
Crambus hortuellus Zell., Chil. et Cram., p. 24 (1863).
Crambus Hortuellus Hein., Schm., Vol. I., p. 125 (1865).
Crambus topiarius Zell., Stett. Ent. Zeit., Vol. XXVII., p. 155 (1866).
Crambus hortuellus Praun, Tineidæ, Plate II., fig. 3 (1869).
Crambus topiarius Grote, Can. Ent., Vol. XII., p. 17 (1880).
Crambus topiarius Grote, Papilio, Vol. II., p. 74 (1882).
Crambus topiarius Felt, Grass-eating Ins., pp. 75, 87 (1894).
Crambus topiarius Scud., Ins. Life, Vol. VII., p. 1 (1894).
Crambus hortuellus Meyr., Handb. Br. Ent., p. 391 (1895).

Expanse of wings, 16–22 mm. Palpi pale cinereous, shining fuscous on the outside ; head and thorax pale cinereous. Fore wings very pale cinereous, gradually changing to ochreous outwardly ; intervenular spaces fuscous brown ; a brown oblique line, arising a little before the middle of the costa, runs obliquely half way to the cell, then bends toward the submarginal line and nearly joins another oblique costal line of the same color ; subterminal line fuscous brown, edged outwardly with dark lead-colored scales, arising from the outer third of the costa, crosses the wings to the outer fourth of the hind margin, forming an obtuse angle in the middle of its course ; an oblique leaden streak in the apical portion of the subterminal space. Terminal line black above, followed by three black dots below. Fringes silvery gray. Hind wings pale gray to dark gray, with a darker terminal line not reaching the anal angle ; fringes whitish. (Fig. 1, *f*.)

Habitat. — Maine, Massachusetts, New York, California, Europe. Food, grass, cranberry, sheep-sorrel.

"*Egg.* — When first laid, pellucid white, obovate, broadly rounded at both extremities, but slightly more so at base than at summit; broadest barely below the middle, 0.36 mm. high and 0.3 mm. broad, with about twenty-three straight and vertical ribs of slight elevation reaching to the dome of the summit, their interspaces crossed by finer, horizontal, raised cross-lines, which traverse also the vertical ribs, giving them a beaded appearance, the surface thus broken up into quadrangular cells whose length (the width

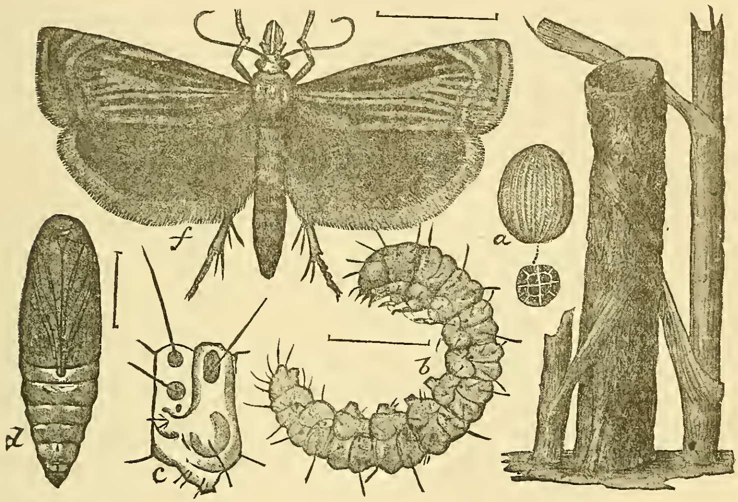

Fig. 1. — *Crambus hortuellus:* *a*, egg, with summit much enlarged; *b*, mature larva; *c*, one of the abdominal segments of larva; *d*, pupa; *e*, nest of young larvæ in grass; *f*, imago — all enlarged. — From "Insect Life."

of the interspaces between the ribs) in the middle of the egg is 0.04 mm., and whose height is scarcely 0.02 mm., the surface itself very delicately shagreened. On the dome of the summit the surface is broken into polygonal cells which are about 0.04 mm. in diameter below, and grow smaller toward the apex." (Fig. 1, *a*.) (Scudder.)

"*Larva, First Stage.* — Head diameter, 0.2 mm.; body diameter, 0.125 mm.; length, 0.99 mm. General color a smutty white; head a little darker than the rest of the body. Scattered hairs occur on the head; numerous small dark-colored tubercles occur on the body, each bearing at least one hair." (Felt.)

"*Larva, Last Stage.* — Head shining luteo-castaneous, the ocellar field, labrum and clypeus black. Body pallid fuliginous, the harder parts glistening; dorsal shield of first thoracic segment luteous, inconspicuous; surface covered with longer or shorter erect bristles, which are very fine, and taper to an exquisitely fine point; they are blackish at base, but beyond testaceous; the longer ones are nearly as long as the breadth of the body, and are situated in lateral and infrastigmatal series; the shorter ones are hardly as long as the segments, and are distributed on the sides of the body; there is also a series of intermediate in length and laterodorsal in position, situated in the middle of the larger anterior division of the segments, while the lateral series lies on the smaller posterior section; under surface and prolegs pallid, the claws luteous. Length, 15 mm." (Fig. 1, *b* and *c*.) (Scudder.)

"*Chrysalis.* — Nearly uniform, very pale honey yellow, more pallid beneath; the wings, excepting at base, with a very slight olivaceous tinge; all the thoracic and the first two abdominal segments, as well as the wings and legs, finely edged at the incisures with dark castaneous, darkest near the head; all the abdominal segments are bordered posteriorly, at least on the dorsal surface, with pale testaceous; lips of spiracles fuscous; cremaster blackish or blackish fuscous. Length, 7.75 mm.; breadth, 2.25 mm." (Fig. 1, *d*.) (Scudder.)

CRAMBUS PERLELLUS. (Plate III., fig. 14.)

Phalæna Perlellus Scop., Ent. Carn., p. 243, No. 620 (1763).
Tinea Argentella Fab., Syst. Ent., p. 658 (1775).
Tinea Perlella Wien. Verz., p. 134 (1776).
Tinea Perlella Knoch., Beitr., Vol. I., p. 68, Plate IV., fig. 6 (1781).
Tinea Perlella Goeze, Ent. Beitr., Vol. III., part 4, p. 142 (1783).
Tinea Perlella Schrank, Faun. Boic., Vol. II., p. 102 (1793).
Tinea Dealbella Thunb., Diss. Ent., Vol. VII., p. 84 (1794).
Tinea perlella Fab., Ent. Syst., Vol. III., part 2, p. 292 (1794).
Tinea argentella Fab., Ent. Syst., Vol. III., part 2, p. 296 (1794).
Crambus argenteus Fab., Ent. Syst., Suppl., p. 471 (1799).
Tinea Perlella Hüb., Tineæ, Plate VI., fig. 40 (1803).
Chilo Perlellus Zinck., Germ. Mag., Vol. II., p. 97 (1817).
Chilo Perlellus Treits., Schm. Eur., Vol. IX., part 1, p. 129 (1832).
Crambus argyreus Steph., Ill. Br. Ent. Haust., Vol. IV., p. 318 (1834).
Crambus Arbustorum Steph., Ill. Br. Ent. Haust., Vol. IV., p. 319 (1834).
Crambus argentellus Steph., Ill. Br. Ent. Haust., Vol. IV., p. 319 (1834).
Crambus perlellus Dup., Nat. Hist. Lep., Vol. X., p. 114, Plate CCLXXIV., fig. 2 (1836).
Crambus Perlellus H. S., Schm., Vol. IV, p. 66 (1849).
Crambus perlellus Zell., Stett. Ent. Zeit., Vol. X., p. 313 (1849).
Crambus perlellus Zell., Bresl. Zeit., Vol. III., p. 11 (1850).
Crambus Argentellus Wood, Ind. Ent., p. 215, No. 1488 (1854).
Crambus perlellus Staint., Man., Vol. II., p. 184 (1859).
Crambus perlellus Zell., Chil. et Cram., p. 49 (1863).
Crambus innotatellus Walk., Lep. Het., Vol. XXVII., p. 156 (1863).
Crambus inornatellus Walk., Lep. Het., Vol. XXVII., p. 157 (1863).
Crambus sericinellus Zell., Chil. et Cram., p. 49 (1863).
Crambus inornatellus Clem., Pr. Ent. Soc. Ph., Vol. II., p. 418 (1864).
Crambus Perlellus Hein., Schm., Vol. I., part 2, p. 143 (1865).
Crambus perlellus Praun, Tineidæ, Plate II, fig. 15 (1869).
Crambus sericinellus Grote, Can. Ent., Vol. XIII., p. 66 (1881).
Crambus innotatellus Felt, Grass-eating Ins, pp. 74, 87 (1894).
Crambus perlellus Meyr., Handb. Br. Ent., p. 393 (1895).

Expanse of wings, 20 mm. Palpi, head and thorax pure silvery white. Fore wings very lustrous, pure silvery white. Hind wings and abdomen white, with a slightly cinereous

tint, especially on the apical part of the wings. All the fringes white.

Habitat. — Nova Scotia, New Brunswick, Quebec, Ontario, Maine, New Hampshire, Massachusetts, New York, Ohio, Illinois, California. Food, grass.

"*Egg.* — Creamy white when first laid, gradually changing to a scarlet color before hatching. Form, elliptical oval; size, .45 mm. by .36 mm. The egg-shell has sixteen longitudinal ridges and numerous smaller transverse ridges.

"*Larva, First Stage.* — Head diameter, .19 mm.; body diameter, .15 mm.; length, 1.05 mm. Body a dull straw color, with irregular reddish blotches on the dorsum. Scattered light-colored hairs occur on the head and body." (Felt.)

Crambus turbatellus. (Plate III., fig. 13.)

Arequipa turbatella Walk., Lep. Het., Vol. XXVII., p. 196 (1863).
Crambus bipunctellus Zell., Chil. et Cram., p. 23 (1863).
Crambus bipunctellus Robs., Ann. Lyc. N. Y., Vol. IX., p. 313 (1870).
Crambus turbatellus Felt, Grass-eating Ins., p. 86 (1894).

Expanse of wings, 22–25 mm. Head, palpi, thorax and fore wings snow white, the last with the median stripe represented by one or two dark-brown dots at the end of the cell, and one or two similar ones below the outer fourth of the cell. The subterminal line consists of a row of dark-brown dots angulated beyond the end of the cell; a terminal row of seven black dots, the one nearest the apex elongated. Fringes white. Hind wings snow white, sometimes with a central pale fuscous shade. Fringes snow white.

Habitat. — Canada, New York, Pennsylvania, Ohio, Illinois. Food plants and early stages unknown.

CRAMBUS ELEGANS. (Plate IV., fig. 8.)

Crambus elegans Clem., Pr. Ph. Ac. Sci., p. 204 (1860).
Crambus terminellus Zell., Chil. et Cram., p. 27 (1863).
Crambus elegans Zell., Stett. Ent. Zeit., Vol. XXXIII., p. 473, Plate II., fig. 5 (1872).
Crambus elegans Zell., Beitr., p. 93 (1872).
Crambus elegans Zell., Exot. Mic., p. 45 (1877).
Crambus elegans Felt, Grass-eating Ins., pp. 74, 86 (1894).

Expanse of wings, 12–15 mm. Palpi white above, slightly fuscous on the outside; head and thorax white, fuscous on the sides. Fore wings white; base of costa streaked with bright brown with a brassy lustre; a patch of brown on the hind margin near the base, and a short curved streak near its middle, which forms with its opposite, when the wings are closed, a semicircular dorsal line, beyond which the wing is thickly dusted with brown; a broad brown band, very broad on the costa, where it encloses a small white spot and a nearly straight brown subterminal line resting on a silvery-white ground. A marginal row of fine black points on the silvery terminal space. Fringes metallic cinereous. Hind wings pale lustrous cinerous, with lighter fringes.

Habitat. — Ontario, Maine, Massachusetts, New York, New Jersey, Illinois, Ohio, Pennsylvania, Maryland, Texas. Food, grass.

"*Egg.* — Creamy white when first laid, gradually turning to an orange-buff color before hatching. Form, oval; size, .42 mm. by .30 mm. The egg-shell has sixteen longitudinal ridges and numerous smaller transverse ridges.

"*Larva, First Stage.* — Head diameter, .2 mm.; body diameter, .125 mm.; length, 1.09 mm. Head and thoracic shield light brown; body a dirty straw color. Scattered hairs occur on the head and body." (Felt.)

CRAMBUS MYELLUS. (Plate II., fig. 7.)

Phalæna Pinetella Scop., Ent. Carn., p. 244 (1763).
Tinea Conchella Wien. Verz., p. 134 (1776).
Tinea Pinetella Knoch., Beitr., Vol. I., Plate IV., fig. 5 (1781).
Tinea conchella Wien. Verz., Illig. ed , Vol. II., p. 83 (1801).
Tinea Myella Hüb., Tineæ, Plate VI., fig. 37 (1803).
Tinea Pinetella Schrank, Faun. Boic., Vol. II., p. 101 (1804).
Bombyx Pineti Esp., Suppl., p. 54, Plate LXXXIX , figs. 4, 5 (1807).
Chilo Conchellus Zinck., Germ. Mag , Vol. II., p. 74 (1817).
Catoptria Conchalis Hüb., Verz., p. 365 (1818).
Chilo conchellus Tr., Schm., Vol. IX , part 1, p. 97 (1832).
Crambus conchellus Dup., Nat. Hist. Lep., Vol. X., p. 91, Plate CCLXXI. (1836).
Crambus Myellus H. S , Schm., Vol. IV., p. 64 (1849).
Crambus Hereyniæ Hein., Bresl. Zeit., p. 3 (1854).
Crambus latiradiellus Walk., Lep. Het., Vol. XXVII., p. 157 (1863).
Crambus interruptus Grote, Can. Ent , Vol. IX., p. 101 (1877).
Crambus interruptus Grote, Can. Ent., Vol. XII., p. 15 (1880).
Crambus myellus Meyr., Handb. Br. Lep., p. 392 (1895).

Expanse of wings, 19–24 mm. Head white above ; palpi white above and beneath, brown on the outside ; thorax white above, brownish on the sides. Fore wings pale ferruginous, with a snow-white stripe extending through the middle of the wing from the base to near the outer border ; this stripe and also the apical portion of the wing edged with dark ferruginous ; two slightly curving, oblique, dark ferruginous bars cross the white stripe, one at the middle of the wing, the other very near the outer end of the stripe. A terminal row of black dots. Fringes dark smoky fuscous, cut by white in three or four places. Hind wings pale fuscous.

Habitat. — Nova Scotia, Maine, Europe. Early stages and food plant unknown.

Crambus luctiferellus luctuellus. (Plate II., fig. 8.)

Crambus luctuellus H. S., Schm., Vol. VI., p. 145, Plate III., fig. 21 (1852).

Expanse of wings, 20–22 mm. Head white above and in front; palpi white above and beneath, dark brown on the outside. Fore wings dark cinnamon brown, with a white stripe through the middle, extending from the base to near the outer margin, gradually widening outwardly, and interrupted by two broad, oblique, dark-brown bars, the inner one a little beyond the middle of the wing, the outer one very near the end of the white stripe, each curved on the sides toward each other. A terminal row of black dots. Fringes dark smoky brown, metallic. Hind wings fuscous.

Habitat. — Labrador, Washington, Europe. Early stages and food plant unknown.

Crambus vulgivagellus. (Plate V., fig. 15.)

Crambus vulgivagellus Clem., Pr. Ph. Ac. Sci., p. 204 (1860).
Crambus aurifimbrialis Walk., Lep. Het., Vol. XXVII., p. 157 (1863).
Crambus chalybirostris Zell., Chil. et Cram., p. 40 (1863).
Crambus vulgivagellus Riley, Dept. Agr., 1881–82, pp. 179–183 (1881).
Crambus vulgivagellus Saund., Can. Ent., Vol. XIII., pp. 181, 199 (1881).
Crambus vulgivagellus Lintn., Rep. Ins. N. Y., Vol. I., p. 127 (1882).
Crambus vulgivagellus Fern., Stand. Nat. Hist., Vol. II., p. 276 (1885).
Crambus vulgivagellus Osborn, Ins. Life, Vol. VI., pp. 72, 78 (1893).
Crambus vulgivagellus Felt, Grass-eating Ins., pp. 69, 85 (1894).

Expanse of wings, 20–39 mm. Palpi very long, heavily scaled at the tip, luteous, dark fuscous on the outside; head and thorax luteous. Fore wings luteous or dull yellowish, with numerous fuscous streaks formed by atoms between the veins, and two in the cell. A terminal line of seven black dots. Fringes with a golden lustre. Hind wings fuscous; fringes long, pale yellowish. (Fig. 2, *d.*)

This is a very common insect, and the amount of damage done by the larvæ is very great, hundreds of acres of grass land sometimes being destroyed. The larva spins a delicate web among the roots of the grass, and gradually forms a tube in which it is entirely concealed. As it increases in size it extends the tube downward into the ground, and when the insect is full grown the tube is sometimes nearly two inches in length.

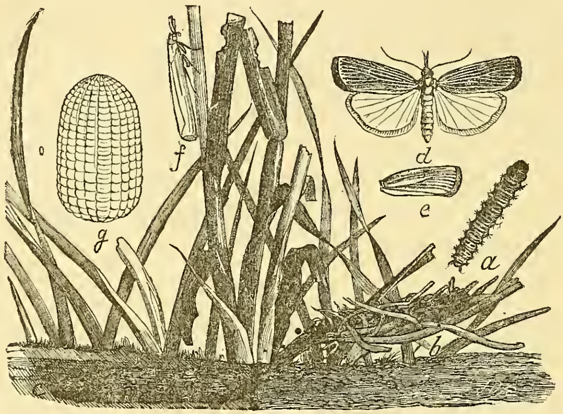

FIG. 2. — *Crambus vulgivagellus: a*, larva; *b*, the larval case in the grass; *c*, the cocoon in the ground; *d*, the moth, a dark specimen; *e*, wing of a light specimen; *f*, the moth at rest; *g*, the egg enlarged, its natural size shown beside it. — From the Department of Agriculture.

Habitat. — Nova Scotia, Ontario, Massachusetts, New York, New Jersey, Pennsylvania, North Carolina, Ohio, Illinois, Missouri, Texas, California, Vancouver Island. Food, grass, wheat, rye and other grains.

"*Egg.* — A pale straw color when first laid, gradually turning to an ochreous buff color before hatching. Form, elliptical oval; size, .45 mm. by .36 mm. The egg-shell has twenty longitudinal ridges and numerous smaller transverse ridges. (Fig. 2, *g*.)

"*Larva, First Stage.* — Head diameter, .19 mm.; body diameter, .175 mm.; length, 1.25 mm. Head a dark brown; thoracic shield olive, and the body a straw-yellow color. Scattered light-colored hairs occur on the head and on the numerous small brownish tubercles on the body.

"*Larva, Late in the Fall.* — Length, 2.5 mm. Head jet black; thoracic shield a deep brown; body brown, with deep-brown tubercles. The fifth to thirteenth segments inclusive are divided into cephalic and caudal portions by a short transverse constriction." (Fig. 2, *a.*) (Felt.)

"*Cocoon.* — Average length, .9 inch; diameter at the broadest part, .24 inch. The shape is subcylindrical, but varying from an almost uniform diameter to an enlargement of the lower portion to twice the diameter of the upper part." (Fig. 2, *c.*) (Lintner.)

"*Pupa.* — Average length, about .4 inch; average greatest diameter, .1 inch. Color, pale brown. Head case projected at the tip, and eye cases prominent. Tip of wing covers rounding over the segment, the inner wing cover showing its margin over more than three segments. The stigmata appear as minute tubercles. Anal tip dark brown, blunt, and slightly excavated beneath." (Lintner.)

Crambus biothanatalis. (Plate IV., fig. 1.)

Crambus biothanatalis Hulst, Tr. Am. Ent. Soc., Vol. XIII., p. 166 (1886).
Crambus behrensellus Fern., Ent. Am., Vol. III., p. 37 (1887).

Expanse of wings, 17–20 mm. Palpi, head and thorax ochre-yellow. Fore wings light ochreous, thickly sprinkled with fuscous; median space lighter, with two broken ochre cross-lines forming scallops on the costal half of the wing, each with a tooth inwardly below the middle. A terminal row of seven black points, resting on an ochre-yellow band. Fringes dull golden, with metallic lustre. Hind wings and abdomen fuscous.

Habitat. — California. Early stages and food plant unknown.

Crambus ruricolellus. (Plate II., fig. 14.)

Crambus ruricolellus Zell., Chil. et Cram., p. 40 (1863).
Crambus ruricolellus Felt, Grass-eating Ins , pp. 67, 84 (1894).

Expanse of wings, 18–20 mm. Palpi pale ochreous, tinged with fuscous on the outside; head and thorax pale

ochreous. Fore wings very pale ochreous, with orange-brown scales arranged in lines along the interspaces, more or less diffused on the costal half; a median line of orange-brown scales arising from the middle of the costa, extending out to the end of the cell, where it curves and runs in a nearly straight line to the basal third of the hind margin; a subterminal line, arising from the outer third of the costa, forms a semicircle to a point two-thirds across the wing, then runs nearly straight to the hind margin. Terminal line composed of a marginal row of brown dots. Fringes golden. Hind wings pale gray, darker outwardly; fringes lustrous white.

Habitat. — Ontario, Maine, New Hampshire, New York, Pennsylvania, Ohio, Illinois. Food, grass and sheep sorrel.

"*Egg.* — Creamy white when first laid, gradually turning to an orange-buff color before hatching. Form, elliptical oval; size, .41 mm. by .33 mm. The egg-shell has twenty longitudinal ridges and numerous smaller transverse ridges.

"*Larva, First Stage.* — Head diameter, .225 mm.; body diameter, .175 mm.; length, 1.2 mm. Head nearly black; thoracic shield a dark reddish brown; body whitish translucent, with many pale rufous spots on the dorsum of the fifth to the twelfth segments, inclusive. Scattered dark-colored hairs occur on the head and body. Late in the fall the head and thoracic shield are almost black, the pale rufous spots have developed into dark-brown tubercles, and the body has become deep brown." (Felt.)

Crambus anceps. (Plate II., fig. 10.)

Crambus anceps Grote, Can. Ent., Vol. XII., p. 17 (1880).

Expanse of wings, 18 mm. Head, palpi and thorax dark fuscous. Fore wings dark brownish fuscous, crossed by two dark, reddish-brown angulated lines, which seem to be formed of short parallel dashes located so as to form strong outward angles above the middle of the wing, then curving in for a short distance and running parallel to the outer margin. These lines are connected with each other by a

dark, reddish-brown stripe above and parallel to the fold. Median line fused with a dark outer discal spot. Fringes metallic fuscous. Hind wings fuscous, with traces of subterminal line.

Habitat. — California. Early stages and food plant unknown.

CRAMBUS TETERRELLUS. (Plate III., fig. 10.)

Chilo teterrellus Zinck., Germ. Mag., Vol. IV., p. 252 (1821).
Crambus camurellus Clem , Pr Ph. Ac. Sci., p. 203 (1860).
Crambus terrellus Zell., Chil. et Cram., p. 27 (1863).
Crambus teterrellus Murtf., Bull. U. S. Dep. Agr., No. 30, p. 53 (1893).
Crambus teterrellus Felt, Grass-eating Ins , pp 66, 84 (1894).

Expanse of wings, 15–21 mm. Palpi fuscous, whitish above; head whitish; thorax whitish above, reddish fuscous on the scapulæ. Fore wings pale ochreous, dusted with fuscous, with an irregular fuscous patch on the outer part of the cell and in the submedian space, extended more or less toward the base of the wing; a faint brown median line, arising from the costa a little beyond the middle, forms an outward angle at the end of the cell and another on the median space, then terminates at the middle of the hind margin; the subterminal line forms an obtuse angle a little above the middle of the wing, edged outwardly by a faint silvery line. A terminal row of black points. Fringes dark, but with a silvery hue. Hind wings light gray; fringes lighter.

Habitat. — Maine, New York, Pennsylvania, Ohio, North Carolina, Georgia, Florida, Alabama, Missouri, Texas. Food, grass.

"*Egg.* — Obconical, .5 mm. long, beautifully sculptured, under the lens, with longitudinal ridges and finer cross-lines, giving it a checkered appearance. Color, bright salmon pink.

"*Larva.* — At first of a dingy cream white, minutely sprinkled with brown, with brown head. At maturity 15 mm. in length by 2 mm. in diameter, subcylindrical, slightly larger across the thoracic segments. Color yellowish or greenish white, with dull-green medio-dorsal stripe.

The surface is much roughened with impressed lines, with conspicuous raised corneous plates, from each of which arises a long, coarse, tapering, yellow-golden hair. Head with protruding lobes and rugose surface, and of a dull whity-brown color. Cervical shield inconspicuous, darker than the head." (Miss Murtfeldt.)

Crambus decorellus. (Plate I., fig. 15.)

Chilo decorellus Zinck., Germ. Mag., Vol. IV, p. 250 (1821).
Crambus polyactinellus Zell., Chil. et Cram., p. 25 (1863).
Crambus decorellus Zell., Beitr, Vol. I., p. 92 (1872).
Crambus Goodellianus Grote, Can. Ent., Vol. XII., p. 17 (1880).
Crambus bonusculalis Hulst, Tr. Am. Ent. Soc., Vol. XIII., p. 167 (1886).
Crambus decorellus Fern., Ent. Am., Vol. IV., p. 44 (1888).
Crambus decorellus Felt, Grass-eating Ins., p. 84 (1894).

Expanse of wings, 19 mm. Palpi, head, thorax and abdomen very pale ochreous. Fore wings pale ochreous, with the veins shaded with fuscous; two dark ochre cross-lines, the median at the outer edge of the cell bent at its first third, and an outward tooth at its second; subterminal line edged on the outer side with fuscous; marginal band ochre-yellow, enclosing a row of black dots. Fringe metallic, black at base, iridescent golden outwardly. Hind wings white or ochreous, tinged with golden outwardly.

Habitat. — Massachusetts, Maryland, Pennsylvania, Georgia, Texas. Early stages and food plant unknown.

Crambus coloradellus. (Plate III., fig. 8.)

Crambus coloradellus Fern., Can. Ent., Vol. XXV., p. 95 (1893).

Expanse of wings, 22 mm. Head, palpi, thorax and fore wings pale silvery straw color; palpi darker on the outside. A white stripe extends from the base of the wing through the cell to the outer margin, bifid beyond the cell. All the veins more or less indicated by pale yellow, edged on each side with a more or less broken row of black scales. A pale-yellow median line crosses the wing at the end of the

cell, where it rounds outwardly and runs nearly straight and vertical to the hind margin. Subterminal line curved within the apex, then running to the hind margin. Both of these lines are faint, and the subterminal is edged on the outside with silvery scales. Terminal row of black dots in a straight line, not following the margin at the lower part, where it rounds outwardly. Fringes silvery metallic. Hind wings white, slightly stained with pale fuscous on the apex.

Habitat. — Colorado. Early stages and food plant unknown.

CRAMBUS BOLTERELLUS. (Plate II., fig. 15.)

Crambus bolterellus Fern., Ent. Am., Vol. III., p. 37 (1887).

Expanse of wings, 22 mm. Palpi, head and thorax pale ochre-yellow, the palpi touched with fuscous on the outer side; patagiæ overlaid with lead-colored scales. Fore wings white, broadly edged with fuscous on the costa; behind this edging a dull-colored stripe extending from the basal fourth of the cell to the apex, the remaining intervenular spaces of the same color. An oblique reddish-brown line crosses the wing a little beyond the end of the cell, with a slight inward angle near vein 2 and a strong outward angle beyond the end of the cell. A second line crosses the wing rather more than half way between the other and the outer margin, of the same color and similarly angulated below the costa, but following the outline of the outer margin below the angle. A row of six or seven black points on the intervenular spaces, at the end of the wing. Fringes pale silvery metallic. Hind wings dull white, with a pale fuscous terminal line not reaching the anal angle. Fringes white.

Habitat. — Texas. Early stages and food plant unknown.

CRAMBUS HULSTELLUS. (Plate III., fig. 3.)

Crambus hulstellus Fern., Can. Ent., Vol. I., p. 56 (1885).
Crambus hulstellus Felt, Grass-eating Ins., p. 83 (1894).

Expanse of wings, 26 mm. Head, thorax and fore wings chalky white; palpi somewhat fuscous on the outside, remainder of the surface white. Fore wings crossed by a twice

angulated brown median line, much darker and heavier on the angles, starting from a point a little below the costa and extending a little beyond the end of the cell, where the first acute angle is formed. The line then runs obliquely across the wing to the middle of the hind margin, forming the second angle just below the cell, where it becomes nearly obsolete. A double yellowish line, starting from the costa near the outer fourth and curving downward, runs nearly parallel with the outer margin to the hind margin, just within the anal angle. Terminal space yellowish, fusing with the line so that it appears double only at the costa; a row of seven black points along the outer margin. Six geminate brown dashes between the median and subterminal lines; three dark-brown elongated patches between the base and the median line. Fringes white, with the base silvery. Hind wings sordid white, with a slightly darker terminal border. Fringes pure white.

Habitat.—Texas. Early stages and food plants unknown.

CRAMBUS ATTENUATUS. (Plate III., fig. 4.)

Crambus attenuatus Grote, Can. Ent,, Vol. XII., p. 18 (1880).
Crambus attenuatus Grote, Can. Ent., Vol. XIII., p. 78 (1881).

Expanse of wings, 25 mm. Palpi, head and thorax white, thickly sprinkled with fuscous. Fore wings narrow, pale cinereous sprinkled with fuscous; a poorly defined, dull-whitish stripe, crossed beyond the cell by an oblique brown line, sometimes indistinct, extends from the base to the outer margin. Subterminal line whitish, bordered on each side with fuscous, running very obliquely from the costa to below the apex, then, more indistinctly marked, very closely following the terminal line. A row of brown dots in the terminal space. Fringes cinereous, with the base fuscous, and the outer edge with metallic lustre. Hind wings fuscous; fringes white.

Habitat. — California, Columbia, Vancouver Island. Early stages and food plant unknown.

CRAMBUS ALBILINEËLLUS. (Plate II., fig. 5.)

Crambus albilineëllus Fern., Can. Ent., Vol. XXV., p. 94 (1893).

Expanse of wings, 26 mm. Head, palpi, thorax and fore wings dull ochre-yellow. The palpi are darker on the outside, and the subcostal, median and veins 5 to 10 are white. A stripe of lead-colored scales extends from the base of the wing just above and parallel to vein 1 to the outer cross-line, and a similar stripe occurs between this and the hind margin. Two lines cross the wing; the median, dark brown, and arising from a point a little beyond the middle of the costa, forms an outward angle very near the costa and an inward angle on the subcostal vein; then a second outward angle, formed at the end of the median vein; and from this point the line runs more or less distinctly across to the middle of the hind margin. The subterminal line, dark brown, finer, dentate, and edged on the outside with lead-colored scales, runs from the costa before the apex across to near the outer margin, thence across the wing nearly parallel with the outer margin. The space from the end of the cell to the apex somewhat stained with brown. Terminal line fine, black, and with a row of black dots. Fringes concolorous with the adjacent part of the wing, but with slight metallic reflections. Hind wings fuscous, fringes lighter.

Habitat. — Southern California. Early stages and food plant unknown.

CRAMBUS HAYTIELLUS.

Chilo Haytiellus Zinck, Germ. Mag., Vol. IV., p. 254 (1821).

Expanse of wing, 10–20 mm. Head and thorax pale ochreous yellow; palpi fuscous on the outside. Fore wings pale ochreous, with a whitish stripe from the base through the cell, and breaking up into lines on the veins outwardly. Costal portion fuscous, quite dark in some specimens. Median line represented by two or three dark-brown dots, one at the end of the cell, one on the fold and one below the fold, the three forming a nearly straight line from the end

of the cell to the basal third of the hind margin. The subterminal line, brown, edged on the outside with silvery scales, slightly serrate, forms a curve below the costa and gives off a tooth on the fold. A terminal row of black dots. Fringes silvery gray. Hind wings pale fuscous.

Habitat. — Texas, Hayti. Early stages and food plant unknown.

CRAMBUS TRICHOSTOMUS. (Plate II., fig. 6.)

Crambus trichostomus Chris., Stett. Ent. Zeit., Vol. XIX., p. 313 (1858).
Crambus trichostomus Möschl., Wien. Monats, p. 379 (1860).
Crambus trichostomus Zell., Chil. et Cram., p. 28 (1863).
Crambus trichostomus Pack., Pr. Bos. Soc. Nat. Hist., Vol XI., p. 55 (1868).

Expanse of wings, 20 mm. Head and thorax dark brown, intermingled with gray scales; palpi very hairy, dark brown, with some gray hairs above. Fore wings dark brown, with a whitish stripe from the middle of the base out to an oblique dark-brown cross stripe on the basal third; this stripe followed by a broad median white shade, extending nearly to the broad white subterminal line; this line commences on the costa a little within the apex, and, curving inward, forms an outward angle near vein 5, thence runs parallel with the outer margin to the fold, where it curves out and terminates near the anal angle. Terminal line dark brown. Lower two-thirds of the terminal space overlaid more or less with white scales. The dark portions of the wing streaked longitudinally with light and dark brown. Fringes dark fuscous. Hind wings dark fuscous; fringes paler.

Habitat. — Labrador. Early stages and food plant unknown.

CRAMBUS OREGONICUS. (Plate III., fig. 9.)

Crambus oregonicus Grote, Can. Ent., Vol. XII., p. 17 (1880).
Crambus oregonicus Grote, N. Am. Ent., p. 68, Plate V., fig. 9 (1880).

Expanse of wings, 17 mm. Head and thorax white above, brown on the sides. Fore wings light ochreous brown, with a longitudinal diffuse white stripe extending across the

median space; a dark-brown, acutely dentate median line, of which sometimes only a brown dash on the median space and another at the extremity of the disk are visible. Subterminal line brown, edged with white outwardly. A white apical patch, and more or less white on the hind margin. Fringes brownish. Hind wings pale fuscous, with narrow terminal line and white fringes.

Habitat. — Oregon. Food plant and early stages unknown.

CRAMBUS BONIFATELLUS. (Plate VI., fig. 6.)

Spermatophthora? bonifatellus Hulst, Ent. Am., Vol. III., p. 135 (1887).

Expanse of wings, 21 mm. Head, palpi and thorax light fuscous. Fore wings yellowish fuscous, with the veins lighter; a whitish dot with a black dentate spot on each side of it near the end of the cell; an indistinct row of dark marginal points. Fringes ochreous. Hind wings smoky fuscous.

Habitat. — Colorado. Early stages and food plant unknown.

CRAMBUS MUTABILIS. (Plate II., fig. 9.)

Crambus mutabilis Clem., Pr. Ph. Ac. Sci., p. 204 (1860).
Crambus fuscicostellus Zell., Chil. et Cram., p. 44 (1863).
Crambus mutabilis Felt, Grass-eating Ins., pp. 64, 83 (1894).

Expanse of wings, 23–24 mm. Palpi, head and thorax fuscous. Fore wings grayish fuscous, luteous on the posterior half; a diffuse grayish median stripe, tinted with luteous, spreading over the costal half of the wing, with the exception of a brown costal margin from the base half way to the apex; a dark-brown dot at the end of the median vein, sometimes streaked with dark fuscous below the vein. Subterminal line dark brown, faint, dentate, usually with a marginal row of brownish dots. A diffuse brown streak from the apex inward toward the cell. Fringes brownish, lustrous. Hind wings gray or pale fuscous; fringes pale fuscous.

Habitat. — Ontario, Massachusetts, Connecticut, New York, Ohio, Illinois, Kentucky, Florida, Louisiana, Nebraska, Texas. Food, grass.

"*Egg.* — Creamy white when first laid, gradually turning to an orange-rufous color before hatching. Form, elliptical oval; size, .51 mm. by .36 mm. The egg-shell has sixteen longitudinal ridges and numerous small transverse ridges.

"*Larva, First Stage.* — Head diameter, .18 mm.; body diameter, .15 mm.; length, 1.1 mm. Head pale yellowish, with a sprinkling of sooty specks; body a rather sooty, semi-transparent white, with irregular rufous blotches along the dorsum; scattered dark-colored hairs occur on the head and body." (Felt.)

Crambus hemiochrellus. (Plate II., fig. 13.)

Crambus hemiochrellus Zell., Ex. Mic., p. 49 (1877).

Expanse of wings, 22 mm. Head and thorax pale ochre-yellow; palpi thickly sprinkled with gray atoms. Fore wings bright ochreous yellow between the white median vein and hind margin, with dusty stripes, and usually a clear yellow stripe along the fold. Costal portion of the wing yellowish gray, darker towards the base. Median line fine, rust brown, forming an acute angle at the end of the cell, and extending in a nearly straight line to the middle of the hind margin. Subterminal line fine, dark brown, dentate on the veins and parallel with the outer margin except at the costal end, where it curves sharply inward and terminates at the outer fourth of the costa. Terminal space dusty gray. Terminal line rather indistinct, upon which, in some specimens, may be seen seven very fine dark-gray dots. Fringes light gray. Hind wings light gray; fringes lighter.

Habitat. — Texas. Early stages and food plant unknown.

Crambus undatus. (Plate III., fig. 12.)

Crambus undatus Grote, Can. Ent., Vol. XIII., fig. 35 (1881).

Expanse of wings, 21 mm. Palpi, head and thorax cinereous or pale grayish, dusted with fuscous. Fore wings narrow, acute, whitish gray, sprinkled with fuscous scales, especially on the basal and costal portions; two distinct, jagged, fuscous brown lines, strongly angulated above the

middle of the wing, the median quite irregular below the cell. A fine dark terminal line. Fringes pale, with metallic lustre. Hind wings pale grayish.

Habitat. — California. Early stages and food plant unknown.

CRAMBUS TRISECTUS. (Plate III., fig. 11.)

Carvanca trisecta Walk., Lep. Het., Vol. IX., p. 119 (1856).
Crambus exsiccatus Zell., Chil. et Cram., p. 37 (1863).
Crambus interminellus Walk., Lep. Het., Vol. XXVII., p. 156 (1863).
Crambus biliturellus Zell., Lep. Westk. Am., p. 7 (1874).
Crambus exsiccatus Grote, Can. Ent, Vol. XII., p. 78 (1880).
Crambus exsiccatus Lintn, Rep. Ins. N. Y., Vol. I., pp. 149-151 (1882).
Crambus exsiccatus Osborn, Dept. Agr., pp. 154-160 (1887).
Crambus exsiccatus Osborn, Bull. U. S. Dept. Agr., No. 30, p. 44 (1893).
Crambus exsiccatus Osborn, Ins. Life, Vol. VI., pp. 72, 78 (1893).
Crambus interminellus Felt, Grass-eating Ins., pp. 62, 83 (1894).

Expanse of wings, 23–32 mm. Palpi whitish, mixed with fuscous scales on the outside; head whitish; thorax very light ochreous. Fore wings very pale ochreous, lighter below the fold and on the outer part; surface sprinkled with dark brown; interspaces beyond the cell marked with whitish lines; a dark-brown spot near the base of vein 2, and a short, dark-brown, oblique, dentate line about half way between this and the end of the wing. Terminal line represented by three or four dark-brown dots. Fringes steel gray, cut by four or five white lines. Hind wings pale grayish white, lighter towards the base; fringes whitish.

Habitat. — Nova Scotia, Ontario, Maine, New Hampshire, Massachusetts, New York, District of Columbia, Illinois, Iowa, Nebraska, Colorado, Missouri, Vancouver Island. Food, grass.

" *Egg.* — A cream-yellow color when first laid, gradually turning to an orange-buff color before hatching. Form nearly elliptical; size, .48 by .33 mm. The egg-shell has sixteen strong longitudinal ridges and numerous smaller transverse ridges.

"*Larva, First Stage.* — Head diameter, .225 mm.; body diameter, .15 mm.; length, 1.2 mm. Head black, thoracic shield a dark brown; body a translucent white, with numerous small black tubercles, each tubercle bearing one or more light-colored hairs. Scattered light-colored hairs occur on the head. When about half grown (late fall) the larva is 2 cm. long. The head and tubercles are black, while the body is a mottled chocolate brown, with a black stripe extending along the dorsal line. Early in the spring the larva is about 3 cm. long. The head and thoracic shield are of a dark umber color; tubercles of the same color; there is a dull pinkish line along the middle of the back; there are also irregular dark wavy subdorsal and lateral lines; body a pale straw color.

"*Pupa.* — Thorax and head brown; abdomen rufous; spiracles dark brown; length about 2 cm.

"*Cocoon.* — Oval, composed of a thick layer of bits of grass, with particles of soil adhering to the outside. Inside, the cocoon is smooth and thinly lined with silk. The cocoon was made just below the surface." (Felt.)

Crambus laciniellus. (Plate IV., fig. 7.)

Crambus laciniellus Grote, Can. Ent., Vol. XII., p. 18 (1880).

Expanse of wings, 26–28 mm. Palpi pale cinereous, brownish outwardly; head and thorax cinereous. Fore wings pale cinereous ochreous, especially on the costal and outer portions of the wing; a few brown atoms sprinkled over the surface; subterminal line indistinctly marked by ochre scales partially overlaid with brown. A marginal row of three black points above the anal angle. Fringes shining fuscous, with a whitish line at the base. Hind wings pale cinereous, fringes white.

Habitat. — Maine. Food plant and early stages unknown.

Crambus dimidiatellus. (Plate IV., fig. 13.)

Crambus dimidiatellus Grote, Ann. Mag. Nat. Hist., Series V., Vol. II., p. 57 (1883).

Expanse of wings, 35 mm. Palpi ochreous, sprinkled with fuscous atoms; head and thorax pale ochreous. Fore wings with a costal band reaching to the middle of the cell, and curving up toward the apex, ashy brown, inclining to olivaceous. A white stripe extends from the base two-thirds the length of the wing, where it breaks up more or less into venular lines reaching to the outer margin. Hind margin broadly shaded with very pale ashy brown. A marginal row of black points, scarcely visible. Fringes pale ash colored. Hind wings pale silky fuscous; fringes lighter.

Habitat. — Colorado and New Mexico. Food plant and early stages unknown.

Crambus caliginosellus. (Plate IV., figs. 2, 3.)

Crambus caliginosellus Clem., Pr. Ph. Ac. Sci., p. 204 (1860).
Crambus caliginosellus Felt, Grass-eating Ins., pp. 61, 83 (1894).

Expanse of wings, 13–25. Head, palpi and thorax dark fuscous, sprinkled with gray scales. Fore wings dark fuscous, sprinkled with brown or yellowish, and frequently with a few gray scales; median line dark brown, often edged with white, arising a little beyond the middle of the costa, extending outward, forming a very acute angle, thence backward across the end of the cell to the hind margin, a little beyond the middle, and giving off an outward angle on the fold. Subterminal line dark brown, edged outwardly with dark lead-colored scales, and frequently dentate along the first part of its course. It arises from the costa about half way between the median line and the apex, extending down to a point beyond the end of the cell, where it forms an outward angle, thence to the hind margin, a little within the anal angle, giving off an inward angle on the fold. This angle is frequently connected along the fold with the outward angle of the median line; terminal line dark brown, rather indistinct. The lines are often obliterated more or less, especially the median. Fringes dark leaden gray. Hind wings dark fuscous; fringes a little lighter.

Habitat. — Ontario, Massachusetts, New York, Pennsylvania, Delaware, District of Columbia, North Carolina, Illinois, Texas. Food, grass, corn.

"*Egg.* — Creamy white when first laid, gradually turning to an orange-rufous color before hatching. Form elliptical oval, with the ends slightly truncate; size, .39 mm. by .3 mm. The egg-shell has eighteen longitudinal ridges and numerous smaller transverse ridges.

"*Larva, First Stage.* — Head diameter, .15 mm.; body diameter, .125 mm.; length, .875 mm. Color a smutty, translucent white, with irregular reddish spots on the middle line of the back; head a pale amber color. Scattered light-colored hairs occur on the head and body. Five pairs of prolegs occur on the seventh to the tenth inclusive and thirteenth segments." (Felt.)

"The full-grown larva is about one inch in length, of a slender, cylindrical form, and of a pinkish-white color, slightly tinged with brown. The head is dark brown or black. There are several stiff bristles or hairs upon each segment.

"This *Crambid* works upon the centre portion of the plant, just beneath the surface of the soil. It spins silken galleries which extend from the plant several inches just beneath the surface of the soil. Some plants were nearly girdled, and the larvæ were frequently found imbedded in cavities where they had fed upon the plants. In some instances as many as thirty larvæ were found in a single hill of corn, and in many hills the plants had been entirely destroyed." (Beckwith.)

Crambus zeëllus. (Plate IV., fig. 4.)

Crambus zeëllus Fern., Can. Ent., Vol. XVII., p. 55 (1885).
Crambus zeëllus Forbes, Rep. Ins. Ill., Vol. XIV., pp. 14, 15, Plate I, figs. 1, 2, 3 (1885).
Crambus refotalis Hulst, Tr. Am. Ent. Soc., Vol. XIII., p. 166 (1886).
Crambus refotalis Fern., Ent. Am., Vol. III., p. 22 (1887).

Expanse of wings, 18–24 mm. Palpi, head and thorax pale leaden gray. Fore wings dull leaden gray, mixed with ashy and whitish, especially on the outer part, and crossed

beyond the middle by two angulated, dull ochre-yellow lines, overlaid more or less with dark brown. The first or median line crosses the end of the cell, where it is angulated. The second or subterminal, crosses the wing about half way between this last and the end. Terminal line dark brown, and a dark brownish cloud extends obliquely in from the apex to the subterminal line, but does not reach the costa. A narrow, ochre-yellow line, somewhat curved, extends from the middle of the base of the wing to the subterminal line near the anal angle, and a similar line, though less plainly marked, runs parallel between this line and the hind margin. Terminal space more or less gray. The outer margin regularly excavated below the apex. Fringes pale metallic lead color. Hind wings pale fuscous, with lighter fringes.

Habitat. — Maine, Pennsylvania, West Virginia, Illinois, Missouri. Food, corn.

The following descriptions of the larva and pupa are compiled from those published by Prof. S. A. Forbes in the "Fourteenth Report of Noxious and Beneficial Insects of Illinois," pp. 14, 15, 1895: —

Larva. — Head dark chocolate brown, slightly and irregularly rugose, with long yellowish hairs; upon the front a white S-shaped mark; cervical shield yellowish, with a white median line; anterior edge whitish, and an oval black spot on the sides. Below the lateral edges of the cervical shield are two hairy tubercles; second and third segments of thorax each with two rows of hairy tubercles, the anterior of four, the posterior of two large quadrate spaces, sometimes united in the middle. From the fourth to the tenth segment the hairy tubercles above the spiracles are in two transverse rows of four each, those of the anterior row being quadrate with rounded angles, and as large as the interspaces; those of the posterior row transversely elongated, about twice as long as wide. Lateral tubercle of anterior row immediately above the spiracle emarginate at its posterior inferior angle, on all the segments from the sixth to the ninth; on these segments a smaller tubercle behind and beneath the spiracle, and two others between the spiracle and the proleg; a narrow arcuate tubercle, with long hairs outside, in

front of each proleg. Anal shield smooth, reddish brown, with a few long brown hairs; spiracles dark brown. Ventral surface paler than the dorsal. Length of full-grown larva, .6 to .8 of an inch; greatest width, .1 inch.

Pupa. — Pupa smooth, shining, pale brown; abdomen a little darker, without hairs or spines; abdomen with an obtuse horny tip. Length, .4 inch; width, .1 inch.

Crambus luteolellus. (Plate IV., fig. 5.)

Crambus lutcolellus Clem., Pr. Ph. Ac. Sci., p. 203 (1860).
Crambus duplicatus Grote, Can. Ent., Vol. XII., p. 79 (1880).
Crambus luteolellus Felt, Grass-eating Ins., pp. 61, 82 (1894).
Crambus holochrellus Zell. (Manuscript name?)

Expanse of wings, 20–26 mm. Palpi pale yellowish, dusted externally with fuscous; head and thorax ochreous yellow. Fore wings ochre-yellow, dusted more or less with ashy scales, especially outwardly; median line rather broad, yellow, very indistinct, running from the end of the cell to near the middle of the hind margin; subterminal line nearly parallel with the median, forming an outward tooth on the fold; both lines often obliterated. Terminal line very indistinct, sometimes consisting of only a row of points. Fringes concolorous with the end of wing. Hind wings fuscous; fringes much lighter.

This species is very perplexing because of its variability; some specimens before me are clear ochre-yellow, without markings of any kind, and there is every gradation between this and those with the median and subterminal lines well marked. The outer margin also varies more or less in form from straight to emarginate.

Habitat. — Ontario, Maine, New York, North Carolina, Illinois, Missouri, Colorado, Arizona, California. Food, grass.

"*Egg.* — A light rufous color when first laid. Form elliptical oval; size, .42 by .3 mm. There are about fourteen prominent longitudinal ribs and numerous smaller transverse ridges." (Felt.)

CRAMBUS LUTEOLELLUS ULÆ. (Plate IV., fig. 6.)

Crambus ulæ Ckll., Ent. Mon. Mag., Vol. XXIV., p. 272 (1888).
Crambus ulæ Fern., Ent. Am., Vol. IV., p. 44 (1888).

Expanse of wings, 24 mm. This variety differs from the description above only in being a little more ashy beyond the cell. This species is so exceedingly variable that at first I was not disposed to consider this insect (the type of which Mr. Cockerell very kindly gave me) even as a variety. I have before me another specimen, from Arizona, almost identical with Mr. Cockerell's type, and another from Colorado, which is intermediate between this type and some of the eastern forms of *luteolellus*. I am now inclined to think that it may be well to consider *ulæ* a geographical variety of *luteolellus*, but perhaps more material and further study may lead me to modify even this opinion.

Habitat. — Colorado, Arizona. Early stages and food plant unknown.

I saw the type of *Crambus innotatellus* Walk. in the British Museum, but could not study the structure of it. I think it may prove to belong to the genus Chilo.

THAUMATOPSIS MORRISON.

Face rounded; eyes large, hemispherical; ocelli present; antennæ scarcely more than half as long as the costa, pectinate or bipectinate in the male; labial palpi porrect, about as long as head and thorax; maxillary palpi about as long as the head, and triangularly scaled; tongue short; thorax smooth; abdomen in the male with a small anal tuft. Fore wings with twelve veins, 7, 8 and 9 from one stalk, all the rest separate; cell closed. Hind wings with eight veins, 4 and 5 arise near each other or from one point; cell open. Mr. Morrison redescribed *pexellus* Zell., and established the genus *Thaumatopsis* for it. In 1894 Mr. Grote established the genus *Propexus*, with *edonis* as the type; but, as *pexellus* and *edonis* are congeneric, we have adopted the older generic name.

Synopsis of the Species.

1.	Expanse of wings less than one inch,	2.
	Expanse of wings more than one inch,	3.
2.	Fore wings dark brown,	*striatellus.*
	Fore wings yellowish brown,	*pectinifer.*
3.	Median vein white,	4.
	Median vein not white,	5.
4.	A dark-brown streak in the outer part of the cell,	*pexellus.*
	Fore wings without dark streaks,	*magnificus.*
5.	Fore wings pale salmon pink,	*edonis.*
	Fore wings white, with numerous fine dark longitudinal lines,	*repandus.*

Thaumatopsis magnificus. (Plate IV., fig. 11.)

Propexus magnificus Fern., Can. Ent., Vol. 23, p. 30 (1891).

Expanse of wings, 40 mm. Palpi clothed with pale fawn-colored and black scales mixed; head and thorax pale fawn colored, the latter with a dorsal whitish stripe and the inner edge of the scapulæ also white. Fore wings pale fawn colored, and mixed more or less with darker scales, except on the costal region and along the fold. The costa and hind border narrowly edged with white, and the veins striped with white, the median stripe being much the widest; all are more or less expanded on the outer border. Fringes white, and cut by two parallel lines of pale fawn color. Hind wings and abdomen very pale fuscous. Fringes white.

Habitat. — Colorado. Food plants and early stages unknown.

Thaumatopsis pexellus. (Plate IV., fig. 14.)

Crambus pexellus Zell., Chil. et Cram., p. 48 (male) (1863).
Crambus macropterellus Zell., Chil. et Cram , p. 48 (female) (1863).
Thaumatopsis longipalpus Mor., Pro. Bos. Soc. N. H., Vol. XVII., p. 165 (1874).

Expanse of wings, 32 mm. Head, palpi and thorax dull ochre-yellow, intermingled more or less with gray; labial

palpi longer than the head and thorax; antennæ in the male bipectinate; fore wings with the median vein white, and bordered above with dark brown in the outer half of the cell, from which a gray shade extends to the apex, behind which the entire surface of the wings is yellowish gray, except in the fold. Fringes yellowish gray. Hind wings grayish fuscous, paler basally.

Habitat. — Georgia, Missouri, Colorado. Food plant and early stages unknown.

I have seen Zeller's type, now in the British Museum; and Morrison's type, which belongs to the National Museum, is now before me.

Thaumatopsis edonis. (Plate IV., fig. 12.)

Crambus (*Propexus*) *edonis* Grote, Can. Ent., Vol. XII., p. 19 (1880).

Expanse of wings, 34–36 mm. Head, palpi and thorax reddish fuscous; antennæ of the male bipectinate; fore wings reddish fuscous, without markings, but dusted with fuscous on the interspaces and terminally. Fringes fuscous. Hind wings pale fuscous, with paler fringes.

Habitat. — North Carolina, Kansas. Food plants and early stages unknown.

Thaumatopsis repandus. (Plate IV., fig. 15.)

Crambus (*Propexus*) *repandus* Grote, Can. Ent., Vol. XII., p. 19 (1880).

Expanse of wings, 22–32 mm. Head, palpi and thorax whitish, more or less tinged with ashy gray. Fore wings whitish, with numerous fine dark-brown lines in the interspaces; median line broken and acutely angled at the end of the cell. Subterminal line black where it arises from the outer fourth of the costa, but soon changes to brown, forming an inward tooth on vein 7 and an outward tooth near the anal angle. Terminal line black, and broken into three dots between veins 3 and 5. Fringes silvery gray, cut with white three or four times. Hind wings pale yellowish, with white fringes and an indistinct subterminal line.

Habitat. — Texas, Arizona, Kansas, Colorado. Food plant and early stages unknown.

Thaumatopsis striatellus n. sp. (Plate IV., fig. 10.)

Expanse of wings, 22 mm. Head, palpi and thorax dark brown; antennæ dark brown, unipectinate. Fore wings umber brown, striped along the interspaces with dark brown. A white stripe extends from the base of the wing along the cell, near the middle of which it is broken up by a mass of dark-brown scales. Median line wanting. Subterminal line indicated by a curved line of white dots, bordered with dark brown, which extend from the outer third of the hind margin to vein 6. Terminal dark-brown dots scarcely visible. Fringes concolorous with the wing. Hind wings and abdomen slightly darker than the fore wings. Fringes a little lighter.

Habitat. — North Illinios. Described from one male specimen received from Mr. A. Bolter. Food plants and early stages unknown.

Thaumatopsis pectinifer. (Plate IV., fig. 9.)

Crambus pectinifer Zell., Exot. Mic., p. 51, Plate I., figs. 20 *a*, *b* (1877).

Expanse of wings, 19 mm. Head, palpi and thorax pale yellowish brown, sprinkled more or less with darker scales. Fore wings pale yellowish brown, darkest along the costa. A white stripe extends from the base of the wing over the cell, beyond which it breaks up into fine lines. Median line indicated by three small white spots edged with brown, in an oblique line from the end of the cell to the basal third of the hind margin. Subterminal line white, edged with brown, nearly parallel with the outer margin, and visible only below vein 5. Fringes gray, interlined with white. Hind wings pale fuscous, with lighter fringes.

Habitat. — Texas. Food plants and early stages unknown.

EUCHROMIUS Guen.

Head medium; face with a slight cone-shaped projection; eyes hemispherical; ocelli present; antennæ about two-thirds as long as the costa, ciliate in the male, simple in the

female; labial palpi porrect, about twice as long as the head; maxillary palpi about half as long as the labial palpi; tongue well developed, scaled at the base; thorax smooth; abdomen with a medium anal tuft; legs of medium length, the inner spurs half as long as the outer.

Fore wings nearly three times as long as wide, the outer margin entire and rounded, with twelve veins all separate except 8 and 9, which are from one stalk; cell closed. Hind wings with eight veins, 4 and 5 from a stalk; cell open.

EUCHROMIUS OCELLEUS. (Plate V., figs. 13, 14.)

Palparia ocellea Haw., Lep. Brit., p. 486 (1811).
Crambus Cyrilli Costa, Dizion. Univ. di Agric. (1829).
Phycis funiculella Tr., Schmett. Eur., Vol. IX., p. 200 (1832).
Araxes ocellea Steph., Ill. Br. Ent. Haust., Vol. IV., p. 316 (1834).
Phycis cirillella Costa, Faun. Napol. Phycid., p. 2, Plate V., fig. 2 (1836).
Crambus funiculellus Zell., Isis, p. 175 (1839).
Crambus funiculellus Dup., Catalogue, p. 319 (1844).
Crambus Cyrilli Zell., Isis, p. 760 (1847).
Crambus Cyrilli Herrich-Schæffer, Sch. Eur., Vol. IV., Plate XX., figs. 144, 145 (1849).
Eromene ocellea Zell., Chil. et Cram., p. 54 (1863).
Eromene Californicalis Pack., Ann. Lyc. N. H. of N. Y., Vol. X., p. 264 (1873).
Eromene texana Robs., Ann. Lyc. N. H. of N. Y., Vol. IX., p. 154, Plate I., fig. 5 (1875).
Eromene ocellea Leach, Br. Pyralids, p. 87, Plate X., fig. 2 (1886).
Euchromius ocelleus Meyrick, Br. Lep., p. 396 (1895).

Expanse of wings, 19–24 mm. Head, palpi, thorax and fore wings light brownish ochreous, the latter thickly sprinkled with dark brown; an ochre-yellow, more or less oblique band a little beyond the middle, with a narrow metallic band dividing it, and a somewhat similar oblique apical band. The terminal line consists of a row of golden metallic spots, confluent on the apical third, and preceded by a row of eight or nine black points arranged in pairs, except the second above the anal angle, which has three. These black points are on the outer border of a clear field, which is limited within by two fine gray lines, which terminate

above in the oblique apical band. Fringe concolorous with the wing. Hind wings white, more or less tinged with gray.

Habitat. — Texas, Arizona, California, southern Europe, south-western Asia, Africa, Australia, Sandwich Islands. This insect is undoubtedly a native of southern Europe, and has probably been brought to this country in comparatively recent times. The early stages and food plants are unknown. At one time I supposed that the Texas and California examples should be regarded as well-marked varieties, but upon the examination of more material I find all the usual variations among the Texan specimens and also among those from California.

ARGYRIA HÜB.

Head medium; face slightly produced; eyes large, hemispherical; ocelli present; antennæ about two-thirds as long as the costa, ciliated in the male, simple in the female; labial palpi porrect, about twice the length of the head; maxillary palpi about half as long as the labial palpi; tongue well developed, scaly at the base; thorax and abdomen smooth, the latter with an extensible anal tuft in the male; legs rather stout, outer spurs half as long as the inner ones. Fore wings about twice as long as wide, with twelve veins; 8 and 9 from one stalk, all the rest separate. Hind wings two-thirds as wide as they are long, with eight veins; 4 and 5 from one stalk; cell open.

This genus was established by Hübner, in his "Verzeichniss bekannter Schmetterlinge," p. 372, placing *nummulalis* (argentana) Hüb. and *pusillalis* Hüb. under it, and therefore *nummulalis* may be considered the type.

Synopsis of the Species.

1.	Fore wings with an oblique yellow band across the middle,	*auratella.*
	Fore wings without a yellow band,	2.
2.	Fore wings with yellow hind border,	*argentana.*
	Fore wings without yellow hind border,	3.
3.	Fore wings with oblique costal marks,	*lacteëlla.*
	Fore wings without oblique costal marks,	*nivalis.*

ARGYRIA NIVALIS. (Plate V., fig. 1.)

Phalæna Pyralis nivalis Drury, Vol. III., Nat. Hist., p. 25, Plate XIV., fig. 4 (1773).
Hydrocampa (?) *nivalis* Westwood's Drury (1837).
Geometra argentata Emm., Nat. Hist. N. Y. Ag., Vol. V , Plate XL. (1854).
Urola michrochysella Walk., Lep. Het., Vol XXVII., p. 181 (1863).
Catharylla nummulalis Zell , Chil. et Cram., p. 51 (1863).
Argyria argentata Grote, Bull. Buf. Soc., Vol. II , p. 166 (1874).
Argyria nivalis Fern., N. A. Ent., p. 100 (1880).

Expanse of wings, 18–22 mm. Head, palpi, thorax and fore wings white, with a satin lustre. The outside of the palpi, the antennæ, a stripe behind the eyes, the basal edge of the costa, the terminal line and a dot near the middle of the hind margin, dark reddish brown. Fringe and anal tuft yellowish brown. Hind wings and abdomen pure white, with a silky lustre.

Habitat. — Ontario, Maine, New Hampshire, Massachusetts, New York, New Jersey, Pennsylvania, District of Columbia, Florida, Texas, Missouri, Ohio, Illinois. Food plant and early stages unknown. This comparatively common species is found in grass-lands, flying about in company with, and much like, some of the species of *Crambus*, and it is very probable that it feeds on grass.

ARGYRIA ARGENTANA. (Plate V., fig. 2.)

Tortrix argentana Martyn, Psyche, Plate XXXII., fig. 95 (1797).
Argyria nummulalis Hüb., Zutr., figs. 185, 186 (1818).
Urola subænescens Walk , Lep. Het., Vol. XXVII., p. 182 (1863).
Catharylla fuscipes Zell., Chil. et Cram., p. 51 (1863).
Argyria nummulalis Fern., N. A. Ent., p. 100 (1880).

Expanse of wings, 19–23 mm. Head, palpi, antennæ and a stripe backwards from the top of the head bright rust red; sides of the thorax and the fore wings white, with a satin lustre; the hind border orange yellow; basal edge of the costa and terminal line dark reddish brown; fringes much lighter than the terminal line; abdomen and hind wings very pale fuscous, with a silky lustre.

Habitat. — Pennsylvania, Illinois, Georgia, Florida. Food plant and early stages unknown.

ARGYRIA AURATELLA. (Plate V., fig. 3.)

Crambus auratellus Clem., Proc. Acad. N. Sc. Phil., p. 204 (1860).
Urola pulchella Walk., Lep. Het., Vol. XXVII., p. 183 (1863).
Catharylla pulchella Zell., Beitr., p. 95, Plate III., fig. 18 (1872).

Expanse of wings, 13–20 mm. Upper side of palpi, face and top of head, tegulæ and fore wings white, with the lustre of satin; sides of the palpi, antennæ, collar and middle of thorax above, and a band from the apical third of the costa to the middle of the hind margin, bright orange yellow. Terminal line dark red; fringe light orange yellow. Hind wings and abdomen white.

Habitat. — Maine, New Hampshire, Massachusetts, North Carolina, Florida, Illinois, California. Food plant and early stages unknown.

ARGYRIA LACTEËLLA. (Plate V., figs. 4, 5 and 6.)

Tinea lacteëlla Fab., Ent. Syst., Vol. III, part II., p. 313 (1794).
Pyralis albana Fab., Ent. Syst, Sup., p. 476 (1798).
Argyria pusillalis Hüb., Zutr., figs. 167, 168 (1818).
Catharylla lusella Zell., Chil. et Cram., p. 51 (1863).
Catharylla rufisignella Zell., Beitr., p. 96 (1872).
Argyria pontiella Zell., Exotic Micr., p. 59 (1877).

Expanse of wings, 12–16 mm. Top of palpi, face, thorax and fore wings pure white, with a satin lustre; sides of palpi, top of head, collar, a dot on the middle of the costa, one on the middle of the hind margin and a more or less complete line connecting them, a preapical costal triangle divided by an oblique of the ground color and the terminal line, all dark rust red. Fringe rust yellow. Hind wings white, with a silken lustre. In one variety (Plate V., fig. 5) the median stripe of the fore wing is so far obliterated as to have only the costal, marginal and cellular spots, and in the typical *rufisignella* the cellular spot is also obliterated (Plate V., fig. 4). Fig. 6 represents a typical *pusillalis*, of which *lusella* and *pontiella* are synonyms. I have before me a long series passing by insensible grades from *rufisignella* into *lacteëlla*.

Habitat. — Florida, Texas, Jamaica, South America. Food plant and early stages unknown. All the types are still in existence, except that of *pusillalis* Hüb., but of this we have a recognizable figure. The type *lacteëlla* is in the Fabrician collection in Copenhagen, and the Zeller types are in the British Museum.

DIATRÆA Guilding.

Face with a conical projection; eyes large, sub-hemispherical; ocelli absent; antennæ about two-thirds as long as the costa, ciliate in both sexes, more strongly in the male; labial palpi porrect, about three times as long as the head; tongue rudimentary; thorax smooth; abdomen in the male with a moderate anal tuft; legs stout, of medium length, outer spurs about two-thirds as long as the inner. Fore wings, about two and one-half times as long as wide in the male, a little longer in the female, with twelve veins, 8 and 9 from a stalk, 11 and 12 coalesce for a short distance in some of the species; cell closed. Hind wings one and one-half times longer than wide, with eight veins, 4 and 5 from one point or stalked; cell closed.

Synopsis of the Species.

1.	Fore wings bluish gray, without marks or dots,	*idalis.*
	Fore wings yellow or brown,	2.
2.	Fore wings seal brown or yellowish brown,	male *differentialis.*
	Fore wings pale ochre-yellow,	3.
3.	Fore wings with a terminal dark line,	*alleni.*
	Fore wings with terminal dots,	4.
4.	Expanse more than one inch and a half,	female *differentialis.*
	Expanse less than one inch and a half,	*saccharalis.*

DIATRÆA SACCHARALIS. (Plate V., fig. 8.)

Phalæna saccharalis Fab., Ent. Syst., Vol. III., part 2, p. 238 (1894).
Phalæna saccharalis Fab., Skrifter af naturalist. Selak., Vol. III., part 2, p. 63, Plate VIII, fig. 1 (1894).
Diatræa sacchari Guilding, Trans. Soc. Ency. Arts, Vol. XLVI., p. 143 (1832).
Chilo obliteratellus Zell., Chil. et Cram., p. 8 (1863).
Chilo obliteratellus Zell., Ent. Zeit., Vol. XXXIII., p. 465 (1872).
Chilo obliteratellus Feld. & Rghf., Novara., Plate CXXXVII., fig 24 (1874).
Chilo obliteratellus Zell., Exot. Microp., p. 12 (1877).
Chilo crambidoides Grote, Can Ent., Vol. XII., p. 15 (1880).
Diatræa obliteratella Zell., Col. Chil. Cram. & Phy., p. 10, Plate XI, fig. 5 (1881).
Diatræa obliteratella Com., Report Dep. Ag., p. 240 (1881).
Diatræa obliteratella Mœsch., Lep. Fauna von Port, p. 322 (1890).
Diatræa striatalis Snell., Tijds. v. Ent., Vol. XXXIV., p. 349, Plate II., figs. 1–4 (1891).

Expanse of wings, 28–38 mm. Head, palpi, antennæ, thorax and fore wings pale ochre-yellow, the latter with darker venular and intervenular lines ; one discal and seven terminal dots black. Hind wings white in the females, pale yellow in the males. All the fringes are concolorous with the adjacent part of the wings. There is a curved line of more or less distinct brown dots from within the apex across the wing, curving in towards the base of the hind margin, and also a trace of a second parallel line between this and the end of the cell. These lines of dots occur more or less distinctly in the males and also in a few females.

Habitat. — South Carolina, Georgia, Louisiana, Kansas, West Indies, South America. Food plants, corn and sugar-cane.

Egg. — The eggs are flat and circular, 1 mm. in diameter, white when first deposited, but turn yellow before hatching. They are laid early in the spring, upon the leaves of the young cane, near the axils, and, hatching in a few days, the larvæ bore their way into the stems in the immediate vicinity, and work upwards through the soft pith. The larvæ grow very rapidly, and leave their burrows occasionally to

crawl about on the outside of the stalk, and bore in again in a new place. The full-grown larva is about an inch long, rather slender, nearly cylindrical, cream white in color, and has a yellow head. When full grown it bores a hole to the surface, then retires a short distance and transforms into a slender brown pupa, about three-fourths of an inch long. In a few days the moth emerges and lays eggs for another brood, of which there are several in a season. They are supposed to hibernate in the larval stage.

The above account is compiled from the Report of the Department of Agriculture for 1880, p. 240, where remedies are given for this insect.

DIATRÆA ALLENI. (Plate V., fig. 9.)

Diatræa alleni Fern., Ent. Am., Vol. IV., p. 120 (1888).

Expanse of wings, 30 mm. Head, palpi above and middle part of the collar cream white. Outer side of the labial palpi, sides of the head and thorax and the fore wings cream buff. The hind border of the fore wings as far as vein 1, and a few longitudinal streaks beyond the brown discal spot, paler, and the whole surface of the wing evenly and sparsely sprinkled with minute brown scales; terminal line brown, fine, somewhat broken, not reaching the anal angle. Fringes whitish at the base, but darker beyond. Hind wings sordid cream color, but lighter on the basal part. Fringes lighter than the adjacent parts of the wings. Under side of the fore wings pale fuscous, with the brown terminal line reproduced.

Habitat. — Orono, Maine. Early stages and food plant unknown.

Diatræa differentialis. (Plate VI., figs. 7 and 8.)

Diatrœa differentialis Fern., Ent. Am., Vol. IV., p. 120 (1888).

Expanse of wings, 43 mm. in the males, 54–61 mm. in the females. Head, palpi, antennæ, thorax and fore wings seal brown. The top of the head and palpi, and the posterior edge of the fore wings as far as vein 1, somewhat lighter, and the fore wings sprinkled with dark scales; a small dark-brown discal spot at the end of the cell; a terminal row of seven spots of the same color, the one at the anal angle being double. Hind wings pale fuscous, lighter towards the base, which is of the same color as the abdomen. Under side of the hind wings like the upper side in color, and the under side of the fore wings a little darker; legs pale seal brown, darker in front. The female has the head, palpi, thorax and fore wings of a light brownish color, the latter sprinkled with brownish atoms. The discal and terminal spots are similar to those in the male. The remaining parts of the insect are similar to those in the male, except that the shades incline to yellowish. The difference of color between the two sexes, as shown above, is most remarkable.

Habitat. — Florida. Early stages and food plant unknown.

Diatræa idalis n. sp. (Plate VI., fig. 12.)

Expanse of wings, 25–34 mm. Head, palpi, thorax and fore wings pale mouse color, with a faint indication of an oblique row of brown dots across the end of the cell in one specimen. Hind wings pure white. Described from one female in my collection. I have a male from the National Museum, in very poor condition, which is somewhat darker, and indicates that the markings on the fore wings are more prominent. The hind wings are pale gray.

Habitat. — New Jersey, Georgia. I take pleasure in naming this interesting insect for Miss Ida J. Russell, who has rendered me most valuable assistance in my entomological work.

CHILO Zincken.

Face with a conical projection; eyes large, sub-hemispherical; ocelli present; antennæ about two-thirds as long as the costa, ciliate in the male; labial palpi porrect, nearly three times as long as the head; maxillary palpi about as long as the head, triangular, and resting on the labial palpi; tongue short; thorax smooth; abdomen in the male with a small anal tuft; legs stout, of medium length, outer spurs about two-thirds as long as the inner. Fore wings with twelve veins, 8 and 9 from one stalk, all the others separate; cell closed. Hind wings with eight veins, 4 and 5 from one point or stalked; cell closed.

Synopsis of the Species.

1.	Fore wings with metallic fringes and sprinkles, .	*plejadellus.*
	Fore wings without metallic scales, ...	2.
2.	Fore wings with veins interlined with dark, . . .	*densellus.*
	Fore wings with the veins not interlined, ...	3.
3.	Fore wings with the ground color white, . .	*squamulellus.*
	Fore wings with ground color brown, ...	4.
4.	Hind wings dark fuscous, ...	*comptulatalis.*
	Hind wings white, fuscous apically, . . .	*forbesellus.*

CHILO PLEJADELLUS. (Plate V., figs. 10, male, and 11, female.)

Chilo plejadellus Zinck., Germ. Mag., Vol. IV., p. 251 (1821).
Jartheza sabulifera Walk., Lep. Het., Vol. XXVII., p. 185 (1863).
Crambus plejadellus Zell., Chil. et Cram., p. 26 (1863).
Diphryx prolatella Grote, Bull. U. S. Geo. Sur., Vol. VI., p. 273 (1881).
Chilo oryzaeëllus Riley, Rep. Dep. Ag., p. 135, Plate VII., fig. 1 (1882).

Expanse of wings, 22–32 mm. Head, thorax and fore wings pale ochreous; labial palpi quite bushy, clothed with numerous black scales and hairs intermixed. Fore wings with numerous ferruginous scales scattered between the veins, across the end and below the cell; a series of golden metallic scales forms a subterminal line rounded and curved away from the apex; a terminal row of seven black dots. Fringes golden metallic, with metallic scales scattered over the wing. Hind wings rather paler. Female (fig. 3, *d*) much lighter in color than the male, hind wings and abdomen pure white, palpi less bushy, and with less brown scattered over the fore wings.

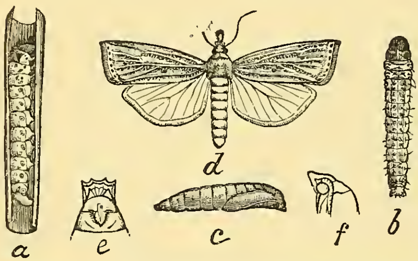

FIG. 3.—*Chilo plejadellus*: *a*, larva, side view in split stem; *b*, larva, back view; *c*, pupa; *d*, female moth, natural size; *e*, tip of pupa from beneath; *f*, head of the same, side view—enlarged.—From Department of Agriculture.

"*Larva.*—Average length, 23 mm. Head dark brown, and furnished with a few scattered brownish hairs (fig. 3, *a* and *b*). Thoracic shield light brown, median line still paler, front margin whitish; a blackish triangular spot, widening towards the lateral margin, on each side of the dorsal line. Color of the body pale yellowish white, slightly transparent, marked with four rather indistinct, pale-purplish stripes, of which those bordering the stigmata are scarcely half as broad as the others. Tubercles large, oval, pale yellowish

and polished; stigmata small, transversely oval, brown, the last pair twice as large as the others. Anal shield yellow, polished, furnished with a row of hairs upon each side and two near the middle; it is marked with a few brownish spots. Legs yellow.

"*Pupa.* — Length, 17 mm. Color, yellowish brown; head, thorax, wing-sheaths and stigmata somewhat darker; eyes black. Head bent forward, its front somewhat pointed. Thorax with very fine transverse striæ. Abdominal segments 5–7 armed dorsally near their anterior margin with numerous very minute brownish spines; all segments with extremely fine granulations. Tip of last segment rounded, with a longitudinal lateral impression; expanded dorsally into two flattened projections, each being divided into broad teeth (fig. 3, *c*, *e* and *f*)." (Riley.)

Habitat. — Pennsylvania, Georgia, Louisiana, Wisconsin. Food plants: this insect is a borer in the stems of rice, and probably of other plants.

CHILO DENSELLUS. (Plate V., fig. 7.)

Chilo densellus Zell., Col. Chil., p. 5, Plate XI., fig. 2 (1881).
Spermatophthora multilineatella Hulst, Ent. Am., Vol. III., p. 184 (1887).

Expanse of wings, 18–21 mm. Head, palpi, thorax and fore wings pale ochreous, with venular and intervenular dark ochreous lines. Discal and seven terminal dots black. Hind wings pale yellow. Females paler, with more pointed fore wings and white hind wings. All the fringes concolorous with the wings.

Habitat. — Florida, Texas, Illinois. Food plants and early stages unknown.

CHILO SQUAMULELLUS. (Plate V., fig. 12.)

Chilo squamulellus Zell., Col. Chil., p. 5, Plate XI., fig. 3 (1881).

Expanse of wings, 18–21 mm. Head, palpi, thorax and fore wings white, sprinkled with brown atoms. The inner cross-line pale straw yellow, and, starting from the basal

third of the costa, extends in a straight line to the end of the cell, where it forms an acute angle and runs to the middle of the hind margin, giving off one tooth in the middle of its course. The outer line white, bordered on each side with a fine, pale, straw-yellow line, and, starting from the outer fourth of the costa, curves around to the fold, where it forms an obtuse inward angle, then runs to the hind margin. Fringe trisected by two fine black lines through it. Hind wings pure white.

Habitat. — Texas. Food plant and early stages unknown.

Chilo comptulatalis. (Plate VI., fig. 9.)

Crambus comptulatalis Hulst, Tr. Am. Ent. Soc., Vol. XIII., p. 167 (1886).

Expanse of wings, 26 mm. Head, palpi, thorax and fore wings dark umber brown, the latter with numerous black scales along the basal half of the submedian fold, broken by a light spot. Black-and-white scales scattered in the outer part of the cell, and a black discal dot surrounded by white scales. The arcuate outer cross-line half way between the cell and end of the wing, and from which indistinct dark lines extend to the terminal dark-brown dots. Hind wings and abdomen dark fuscous throughout.

Habitat. — Illinois, Missouri, Colorado, Nebraska, Vancouver Island. Food plant and early stages unknown.

Chilo forbesellus n. sp. (Plate VI., figs. 10 and 11.)

Expanse of wings, 23–38 mm. Head, palpi, thorax and fore wings dark umber brown, varying in depth of shade according to the freshness of the specimen. Fore wings with more or less white scales on the outer part of the cell, the cellular black dot in the midst of them; a similar series of white scales scattered along the submedian fold, with a black dash near the middle of the wing in the fold and another a little before it. The outer cross-line and terminal row of black dots are visible only in more or less worn specimens. Hind wings white, pale fuscous apically, with a dark-brown broken terminal line not reaching the anal

angle. First two segments of the abdomen white, remaining segments pale yellow. Female larger and lighter in color than the male, discal and terminal dots more plainly visible and hind wings lighter.

Habitat. — New York, Illinois.

There are a male and a female of this species in the National Museum, labelled "From Scirpus, D. C. Kellicot, Buffalo, N. Y." It is probable that this insect is a stem borer in Scirpus.

Named in honor of Prof. S. A. Forbes, from whom it was received, in recognition of his valuable contributions to economic entomology.

Explanation of Plate A.

ANATOMY OF CRAMBUS LAQUEATELLUS.

The original drawings for Plates A, B and C were made by Mr. R. A. COOLEY, under my direction and supervision.

Fig. 1. Side view of denuded body.
Fig. 2. Dorsal view of denuded body.
Fig. 3. Front view of head.
Fig. 4. Ventral view of head.
Fig. 5. Fore leg.
Fig. 6. Tibial epiphysis.
Fig. 7. Middle leg.
Fig. 8. Hind leg, showing the tip of one of the tibial spurs enlarged at the left.
Fig. 9. Two joints from the middle of the female antenna.
Fig. 10. Portion of a joint from male antenna, enlarged, showing sense pits, spines and reticulated surface.
Fig. 11. Portion of hind wing, showing the end of a vein, a spine (*sp*) and scale pits.

a, antenna; *c*, clypeus; *e*, eye; *l*, labrum; *m*, mandibles; *o*, ocelli; *s*, scapula; *sa*, spiny area; *mp*, maxillary palpi; *lp*, labial palpi; *pl*, prothoracic lobes; s^2, mesoscutum; s^3, metascutum; sm^2, mesoscutellum; sm^3, metascutellum; c^1, c^2, c^3, coxæ of the fore, middle and hind legs; *sp*, spine.

Explanation of Plate B.

Fig. 1. Fore wing of Crambus laqueatellus.
Fig. 2. Hind wing of Crambus laqueatellus.
Fig. 3. Fore wing of Chilo plejadellus.
Fig. 4. Hind wing of Chilo plejadellus.
Fig. 5. Fore wing of Euchromius californicalis.
Fig. 6. Hind wing of Euchromius californicalis.
Fig. 7. Fore wing of Prionapteryx achatina.
Fig. 8. Hind wing of Prionapteryx achatina.
Fig. 9. Fore wing of Eugrotea dentella.
Fig. 10. Hind wing of Eugrotea dentella.
Fig. 11. Fore wing of Crambus laqueatellus, showing the spiny area at the base and the loop of modified scales through which the frenulum passes.
Fig. 12. View from the edge of the spiny area from the fore wing of Crambus laqueatellus.
Fig. 13. Male frenulum of Crambus laqueatellus.
Fig. 14. Female frenulum of Crambus laqueatellus.
Fig. 15. Male antenna of Prionapteryx nebulifera.
Fig. 16. Male antenna of Pseudoschœnobius opalescalis.
Fig. 17. Male antenna of Crambus laqueatellus.

Plate A

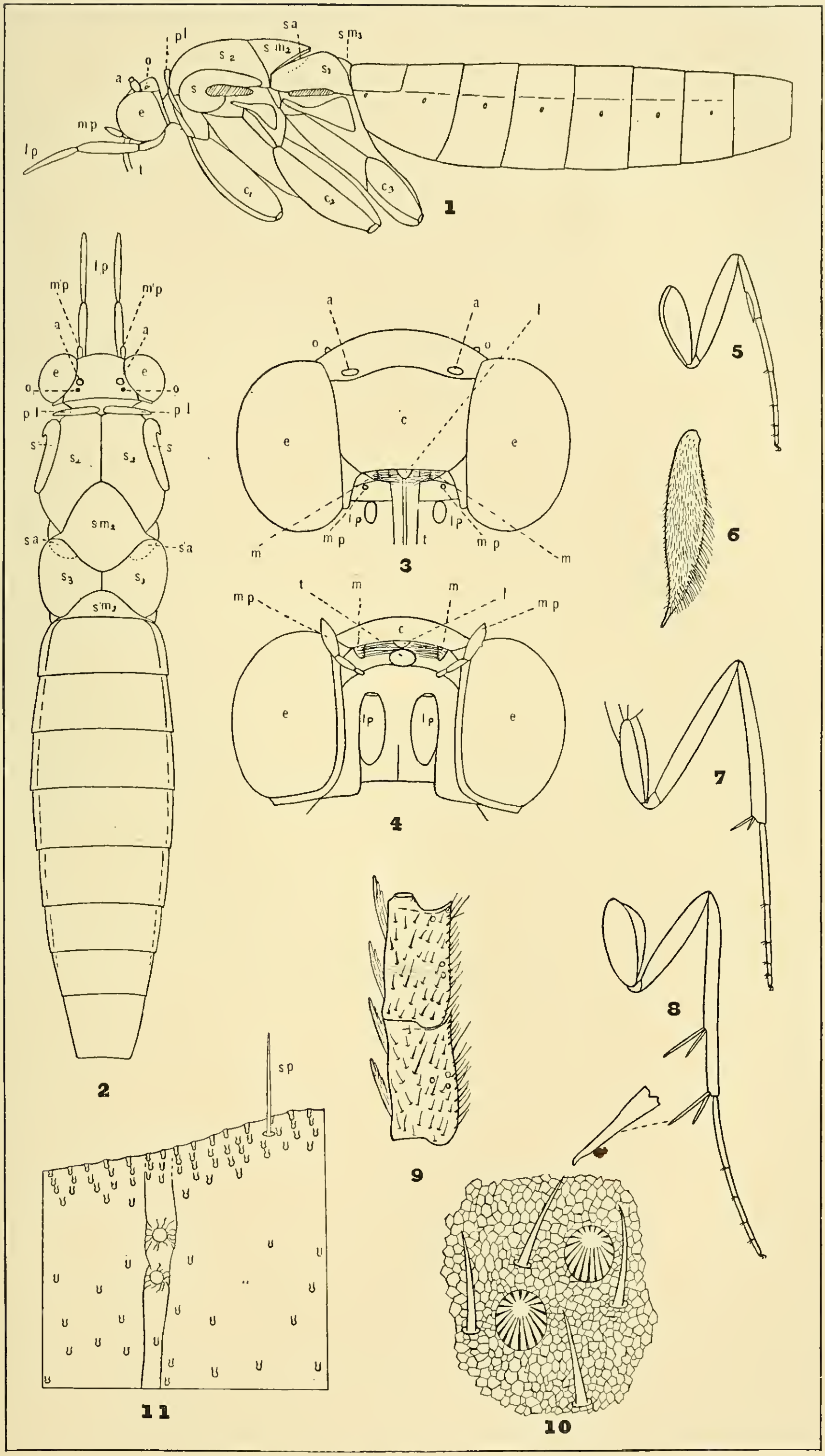

Plate B

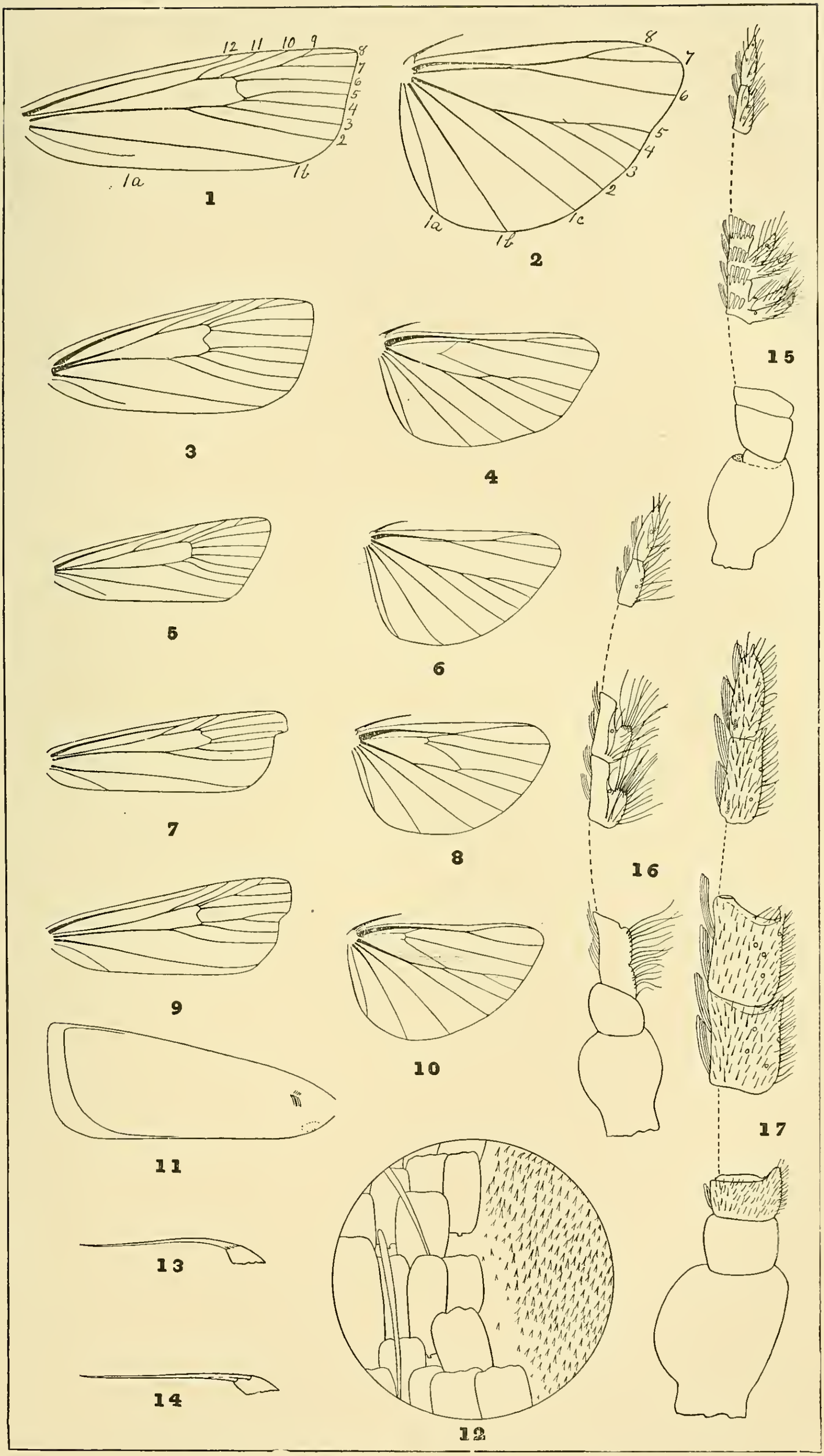
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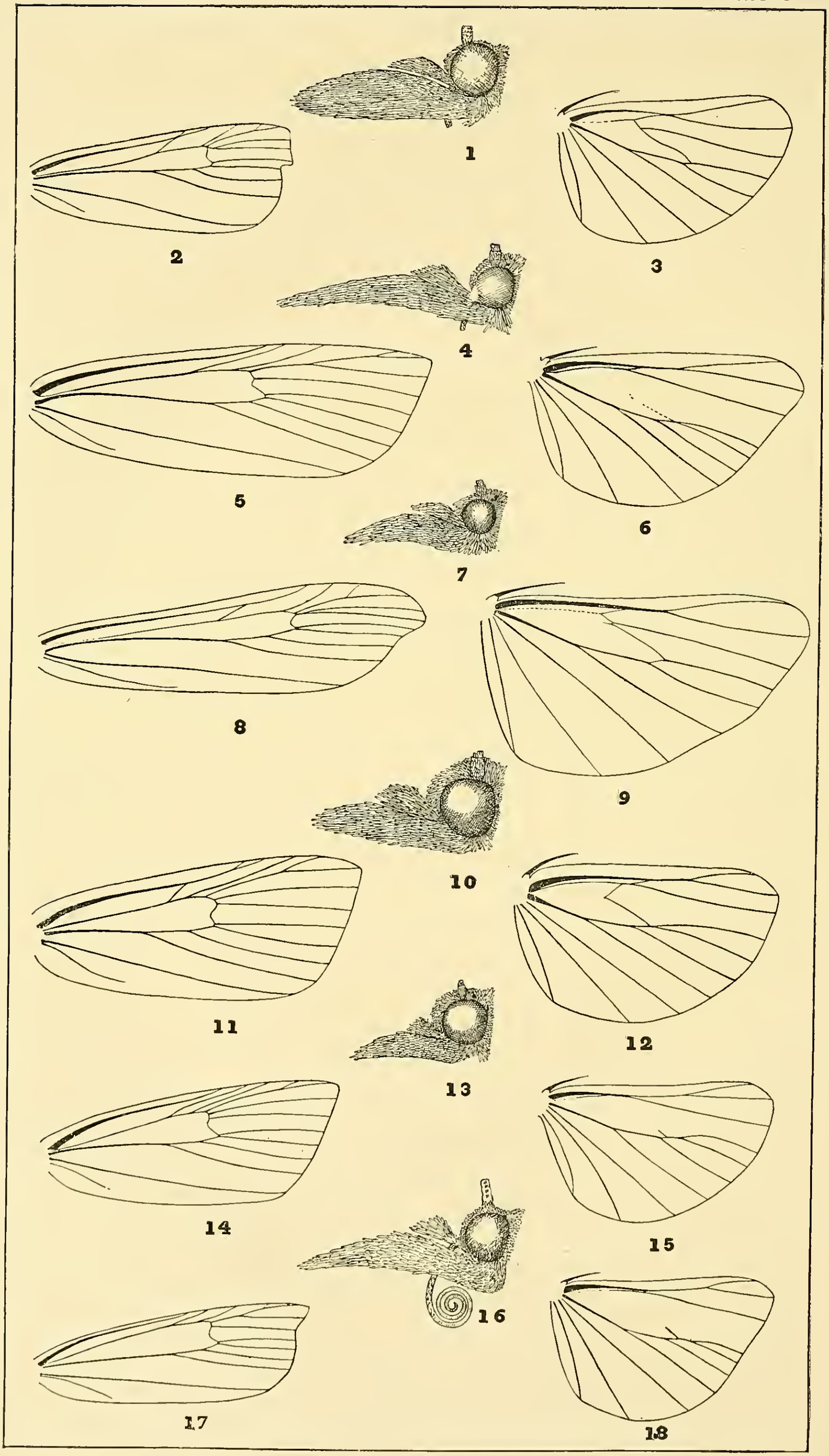
Plate C



Explanation of Plate C.

Fig. 1. Side view of head of Prionapteryx nebulifera.
Fig. 2. Fore wing of Prionapteryx nebulifera.
Fig. 3. Hind wing of Prionapteryx nebulifera.
Fig. 4. Side view of head of Thaumatopsis pexellus.
Fig. 5. Fore wing of Thaumatopsis pexellus.
Fig. 6. Hind wing of Thaumatopsis pexellus.
Fig. 7. Side view of head of Pseudoschœnobius opalescalis.
Fig. 8. Fore wing of Pseudoschœnobius opalescalis.
Fig. 9. Hind wing of Pseudoschœnobius opalescalis.
Fig. 10. Side view of head of Diatræa saccharalis.
Fig. 11. Fore wing of Diatræa saccharalis.
Fig. 12. Hind wing of Diatræa saccharalis.
Fig. 13. Side view of head of Argyria nummulalis.
Fig. 14. Fore wing of Argyria nummulalis.
Fig. 15. Hind wing of Argyria nummulalis.
Fig. 16. Side view of head of Crambus floridus.
Fig. 17. Fore wing of Crambus floridus.
Fig. 18. Hind wing of Crambus floridus.

The original drawings for the six following plates were made by Miss Ella M. Palmer.

Explanation of Plate I.

1. Crambus satrapellus.
2. Crambus leachellus.
3. Crambus pascuellus.
4. Crambus hastiferellus.
5. Crambus carpenterellus.
6. Crambus unistriatellus.
7. Crambus præfectellus.
8. Crambus bidens.
9. Crambus alboclavellus.
10. Crambus agitatellus.
11. Crambus laqueatellus.
12. Crambus multilineëllus.
13. Crambus girardellus.
14. Crambus gausapalis.
15. Crambus decorellus.

Explanation of Plate II.

1. Crambus argillaceëllus.
2. Crambus minimellus.
3. Crambus occidentalis.
4. Crambus hamellus.
5. Crambus albilineëllus.
6. Crambus trichostomus.
7. Crambus myellus.
8. Crambus luctiferellus luctuellus.
9. Crambus mutabilis.
10. Crambus anceps.
11. Crambus hortuellus.
12. Crambus dissectus.
13. Crambus hemiochrellus.
14. Crambus ruricolellus.
15. Crambus bolterellus.

Explanation of Plate III.

1. Crambus cypridalis.
2. Crambus dumetellus.
3. Crambus hulstellus.
4. Crambus attenuatus.
5. Crambus albellus.
6. Crambus pusionellus.
7. Crambus labradoriensis.
8. Crambus coloradellus. Fore wing enlarged.
9. Crambus oregonicus.
10. Crambus teterrellus.
11. Crambus trisectus.
12. Crambus undatus.
13. Crambus turbatellus.
14. Crambus perlellus.
15. Crambus inornatellus.

Explanation of Plate IV.

1. Crambus biothanatalis.
2. Crambus caliginosellus.
3. Crambus caliginosellus.
4. Crambus zeëllus.
5. Crambus luteolellus.
6. Crambus luteolellus ulæ.
7. Crambus laciniellus.
8. Crambus elegans.
9. Thaumatopsis pectinifer.
10. Thaumatopsis striatellus.
11. Thaumatopsis magnificus.
12. Thaumatopsis edonis.
13. Crambus dimidiatellus.
14. Thaumatopsis pexellus.
15. Thaumatopsis repandus.

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Explanation of Plate V.

1. Argyria nivalis.
2. Argyria argentana.
3. Argyria auratella.
4. Argyria lacteëlla.
5. Argyria lacteella.
6. Argyria lacteëlla.
7. Chilo densellus.
8. Diatræa saccharalis.
9. Diatræa alleni.
10. Chilo plejadellus, male.
11. Chilo plejadellus, female.
12. Chilo squamulellus.
13. Euchromius ocelleus.
14. Euchromius ocelleus.
15. Crambus vulgivagellus.

Explanation of Plate VI.

1. Prionapteryx nebulifera.
2. Prionapteryx achatina.
3. Prionapteryx achatina.
4. Prionapteryx cuneolalis.
5. Eugrotea dentella.
6. Crambus bonifatellus.
7. Diatræa differentialis, male.
8. Diatræa differentialis, female.
9. Chilo comptulatalis.
10. Chilo forbesellus, male.
11. Chilo forbesellus, female.
12. Diatræa idalis.
13. Pseudoschœnobius opalescalis.
14. Uinta oreadella.

INDEX OF GENERA.

INDEX OF SPECIES AND SUB-SPECIES.

EIGHTH ANNUAL REPORT

OF THE

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

JANUARY, 1896.

REPORT.

It is proper, in making this first report of the Hatch Experiment Station since its consolidation with the State Experiment Station, that its history and organization should be briefly outlined and made a matter of permanent record. The State station was established by act of the Legislature in 1882, with Prof. Charles A. Goessmann as director. Though located on the college grounds and making use of its land for purposes of experiment, it had no direct connection with it, but was governed by its own board of control. Up to the time of consolidation twelve annual reports had been issued and fifty-seven bulletins.

The Hatch Experiment Station was established under act of Congress, Public No. 112, Feb. 25, 1887. The provisions of this act were accepted by the General Court, chapter 112 of the Acts and Resolves of 1887. At a meeting of the trustees of the Massachusetts Agricultural College, held March 2, 1888, it was voted to establish another department, to be styled "The Experiment Department of the Massachusetts Agricultural College." The name was subsequently changed to the Hatch Experiment Station of the Massachusetts Agricultural College, and Pres. H. H. Goodell was elected director. Five thousand dollars of its income were annually paid over to the State Experiment Station, in consideration of its performing the chemical work required. Previous to consolidation there had been issued seven annual reports, thirty general, three special and seventy-eight meteorological bulletins.

For several years a growing feeling had manifested itself that the two stations should be united, in the interest of economy of administration, work and result.

In 1894 an act was passed by the General Court, chapter 143, to consolidate the Massachusetts Agricultural Experiment Station with the Experiment Department of the Massachusetts Agricultural College. Owing to a trifling error, the

consolidation could not be effected, and the act was amended, chapter 57 of the Acts and Resolves of 1895. The full text, as amended, is as follows: —

SECTION 1. The Massachusetts agricultural experiment station, located at the Massachusetts agricultural college in Amherst, may be transferred to and consolidated with the experiment department of the said college now known as the Hatch experiment station, in the manner hereinafter provided.

SECT. 2. The said Massachusetts agricultural experiment station, at any meeting duly called for such purpose, may, by a vote of two-thirds of the members present, authorize the transfer of all the rights, leases, contracts and property, of every kind and nature, of said station to the Massachusetts agricultural college; and the trustees of said college may, at any meeting duly called for such purpose, accept the same for said college in behalf of the Commonwealth, whereupon such transfer shall be made by suitable conveyance; and when such transfer shall be made, the said Massachusetts agricultural experiment station shall be deemed to be a part of, and to belong to, the experiment department of said college, under such name as said trustees may designate.

SECT. 3. The trustees of said college shall thereafter continue to carry on the experimental and other work for which the Massachusetts station was established, and to administer and apply all the property and funds that may be received by them hereunder, and by virtue hereof, for such purposes. They shall also from time to time print and publish bulletins containing the results of any experimental work and investigations, and distribute the same to such residents and newspapers of the Commonwealth as may apply therefor.

SECT. 4. Nothing herein contained shall operate to affect or discontinue the annual appropriations and payments thereof made and to be made by the Commonwealth for the proper maintenance of experimental work, under section six of chapter two hundred and twelve of the acts of the year eighteen hundred and eighty-two and section one of chapter three hundred and twenty-seven of the acts of the year eighteen hundred and eighty-five; and the payment of said appropriations shall hereafter be made to the treasurer of the Massachusetts agricultural college. The trustees of said college shall make or cause to be made annually to the general court a detailed report of the expenditure of all such moneys, and such further report of the annual work of the experiment department of the college station as the trustees of the college shall deem advisable.

In accordance with this action of the Legislature, at a special meeting of the trustees, held April 16, 1895, it was voted to accept, for the Massachusetts Agricultural College, the transfer of all the rights, leases, contracts and property of every kind and nature of the Massachusetts Agricultural Experiment Station to the Massachusetts Agricultural College. It was voted to consolidate the two stations, under the name of the Hatch Experiment Station of the Massachusetts Agricultural College, and the following organization was adopted: —

Henry H. Goodell, LL.D.,	*Director.*
William P. Brooks, B.Sc.,	*Agriculturist.*
George E. Stone, Ph.D.,	*Botanist.*
Charles A. Goessmann, Ph.D., LL.D.,	*Chemist* (fertilizers.)
Joseph B. Lindsey, Ph.D.,	*Chemist* (foods and feeding.)
Charles H. Fernald, Ph.D.,	*Entomologist.*
Samuel T. Maynard, B.Sc.,	*Horticulturist.*
Leonard Metcalf, B.S.,	*Meteorologist.*
Henry M. Thomson, B.Sc.,	*Assistant Agriculturist.*
Ralph E. Smith, B.Sc.,	*Assistant Botanist.*
Henri D. Haskins, B.Sc.,	*Assistant Chemist* (fertilizers).
Robert H. Smith, B.Sc.,	*Assistant Chemist* (fertilizers).
Charles S. Crocker, B.Sc.,	*Assistant Chemist* (foods and feeding).
Edward B. Holland, B.Sc.,	*Assistant Chemist* (foods and feeding).
Robert A. Cooley, B.Sc.,	*Assistant Entomologist.*
Joseph H. Putnam, B.Sc.,	*Assistant Horticulturist.*
George A. Billings, B.Sc.,	*Assistant in Foods and Feeding.*
Charles A. King,	*Observer.*

ANNUAL STATEMENT

Of the Hatch Fund of the Massachusetts Agricultural College for the Year ending June 30, 1895.

By George F. Mills, *Treasurer pro tem.*

Cash received from United States treasurer,		$15,000 00
Cash received from agricultural department,		861 14
		$15,861 14
Cash paid for salaries,	$8,382 72	
Cash paid for labor,	1,592 88	
Cash paid for publications,	1,476 16	
Cash paid for freight and express,	103 53	
Cash paid for postage and stationery,	51 41	
Cash paid for heat, light and water,	101 90	
Cash paid for chemical supplies,	479 60	
Cash paid for seeds, plants and sundry supplies,	500 71	
Cash paid for fertilizers,	344 08	
Cash paid for feeding stuffs,	373 52	
Cash paid for library,	528 23	
Cash paid for tools, implements and machinery,	867 27	
Cash paid for furniture,	50 92	
Cash paid for scientific apparatus,	534 56	
Cash paid for travelling expenses,	195 37	
Cash paid for contingent expenses,	96 42	
Cash paid for building and repairs,	181 86	
		$15,861 14

Amherst, Mass., Sept. 20, 1895.

I, the undersigned, duly appointed auditor, do hereby certify that I have examined the books and accounts of the Hatch Experiment Station of the Massachusetts Agricultural College for the fiscal year ending June 30, 1895; that I have found the books well kept, and the accounts correctly classified as above, and that the receipts for the time named are shown to be $15,861.14, and the corresponding disbursements $15,861.14. All the proper vouchers are on file, and have been by me examined and found to be correct, there being no balance to be accounted for in the fiscal year ending June 30, 1895.

CHARLES A. GLEASON,
Auditor.

REPORT OF THE BOTANIST.

GEORGE E. STONE.

This department of investigation was established in 1888 and continued until 1892, when, on account of Dr. Humphrey's resignation, it was temporarily discontinued. Last July the department was re-established, and the physiological laboratory is now devoted to experimental work along the lines for which it was largely designed. Owing to the fact that the laboratory and its equipment were being used in other lines of investigation to the middle of September, experimental work in botany was necessarily delayed, and it was not until October that experiments were under way. At the present time, therefore, only a brief report can be offered. It may not be out of place, however, to state concisely some of the details relating to the line of work which is being pursued, reserving a fuller account of the experiments for subsequent publications.

The work of the division falls mainly under two heads, namely, vegetable physiology and vegetable pathology. The first occupies itself with a study of plant diseases, their prevention and cure. The second deals particularly with the function of the plant, whether normal or abnormal, and is concerned with the action of such external influences as heat, light, moisture, etc. It further endeavors to ascertain how far the utilization of these external influences is responsible for the inroads of fungi, and how far the fungi can be controlled by these physiological factors.

Study of Injurious Fungi.

Throughout the entire year a large number of diseased plants is sent in for diagnosis. Work in this line must always be in progress, and the examination of these dis-

eased forms occupies considerable time. Very frequently some of the diseases prove to be new, or at least little understood, and a study of them must be made for the purpose of gaining an accurate knowledge of their characteristics and habits, and thus enable us to treat them in an intelligent manner. It is highly important that the nature of every plant disease be fully understood before any attempt is made to treat it. Any attempt at treatment not based on knowledge is as unscientific as it is impracticable. Among the apparently new diseases occupying our attention at present are bacterial diseases of the strawberry and orchid, a begonia leaf disease, a stem disease of the cultivated aster and a rust on the blackberry. Besides these, observations are being made on a number of other more or less known fungi.

In connection with the study of injurious fungi, numerous tests are being made with new fungicides, especially with solutions which can be used in the greenhouse. These tests are first made directly on the spores in the laboratory, and then the solutions are applied to susceptible or diseased plants in the greenhouse. By means of such tests the effects of the solution on the spores can be readily observed, and the strength of the solution required for spraying can be tolerably well determined.

Nematode Worms.

No class of plants is more frequently sent in during the winter than greenhouse cucumbers affected with these worms, which completely riddle the tender tissues of the roots, much to the detriment of the plants. No satisfactory remedy has as yet been found, though various experiments are now being made in the greenhouse for the purpose of relieving the market gardener from these pests.

Beneficial Fungi (Mycorhiza).

It has been known in Europe for some years that the roots of many plants are covered with fungous growths, the predominance of which — in some instances, at least — is believed to have some bearing on the absence of root

hairs. These facts, with other phenomena apparently of a similar nature which occur in the leguminosæ, etc., have led Frank * to surmise that these fungi play an important role in the assimilation of food material from the soil. As no investigations have been made to our knowledge on the occurrence of fungi on the roots of our native species of plants, Professor Smith and myself have devoted considerable attention during the past summer to work in this direction, for the purpose of determining, first, the prevalence of fungi on roots of our native plants; second, their nature and distribution; third, their relation to the absence of root hairs. Already a large number of plants have been examined, and it is proposed to carry on the investigations during the coming summer, with these additional points in view, — fourth, to prove by means of cultures whether the fungi are really essential to the plant in the assimilation of food from the soil; fifth, if proved, to throw some light, if possible, upon the process of assimilation; sixth, to ascertain whether these fungi are in any way — as Kerner maintains they are — accountable for the difficulty of transplanting certain plants.

Damping Fungi and their Relations to Temperature and Moisture.

Experiments are being made to ascertain the exact relations of the development of the damping fungi to temperature and moisture conditions. A large number of plants subject to damping off are being experimented with in a portion of the greenhouse provided with self-registering instruments. In connection with this line of work, experiments are being made to find out at what temperature the spores of injurious fungi common to the greenhouse commence to germinate. These experiments are undertaken for the purpose of learning to what extent certain diseases can be controlled by temperature and moisture conditions.

* Lehrbuch der Botanik, page 295.

General Botanical Work.

Grass Collection.

Among the specimens sent in by farmers and other citizens of the State for determination are not infrequently grasses. The station possesses already a small collection of these most important plants, and it is hoped that in the course of time a representative of every species peculiar to Massachusetts will be found here, not only for our own use in aiding identification of obscure species, but for the benefit of the student and visitor who may wish to become familiar with them.

Weed Collection.

Any one who is conversant with our ever-extending commercial relations with foreign countries can realize that a considerable number of new species of plants reaches us every year. That most of these may prove perfectly harmless there can be no doubt; but, on the other hand, we do not know but that there is in our State to-day some slumbering pest, some unnaturalized immigrant, which may in a few years become as common as the daisy or shepherd's purse, and prove as disastrous as the Russian thistle. For this reason we wish to extend our collection of State weeds, and keep a careful record of the nature and time of introduction of every species. This department, therefore, requests the co-operation of all those interested in such matters, in its endeavor to make a complete collection and accumulate data bearing on the habits of our weeds.

REPORT OF THE AGRICULTURIST.

WILLIAM P. BROOKS.

Leading Results and Conclusions based upon the Experiments outlined in the Report of the Agriculturist.

Grass and Clover.

1. Nitrate of soda applied in early spring may safely be depended upon to produce a profitable increase in the first crop of hay, but such application will not materially increase the yield of rowen. The amount to be used is from 150 to 200 pounds per acre.

2. Muriate of potash applied to land which is to be seeded to mixed grasses and clovers may be depended upon to increase the proportion of clover in the produce, and consequently to make the hay more highly nitrogenous, and particularly to increase the yield of rowen. The amount needed is about 175 to 200 pounds per acre.

3. Fertilizers for top-dressing grass lands in spring should contain nitrate of soda and muriate or sulphate of potash ; and, to benefit the rowen crop, they should contain also some slower-acting forms of nitrogen, such as sulphate of ammonia, dried blood, dry ground fish, bone meal or tankage. The fish, tankage or bone meal will furnish some phosphate, of which a moderate quantity will be useful.

Corn.

1. The application of muriate of potash has so invariably increased the yield of both stover and grain that the conclusion is irresistible that potash should be more abundant in fertilizers for this crop than is usually the case.

2. There is much evidence that the fertilizer for one acre should furnish at least 80 to 100 pounds of actual potash.

3. A corn fertilizer containing 5 per cent. of potash, applied at the rate of 1,000 pounds per acre, furnishes 50 pounds of actual potash. With such a fertilizer it will pay to use from 75 to 100 pounds of muriate of potash per acre.

4. Four cords of average farm-yard manure will supply about 96 pounds of actual potash; but not all of this will be available the first year, hence it will in most cases be found profitable to use with this manure 75 to 100 pounds of muriate of potash for corn.

Rye.

This crop is most largely increased by muriate of potash and nitrate of soda, but responds much less freely to an application of fertilizers than corn.

White Mustard.

1. In this we have a crop responding most freely to an application of phosphates, indicating that the percentage of phosphoric acid in fertilizers for turnips and cabbages (members of the same family) should be large.

2. White mustard sown yearly in standing corn in the later part of July grows until late in the fall, thus preventing soluble nitrogen compounds from being washed out of the soil. It does not injure the growth of the corn the year it is sown, and the ultimate effect is to make the soil produce larger crops in subsequent years.

Potatoes.

1. Both being used in connection with materials furnishing equal amounts of nitrogen and phosphates, sulphate of potash gives larger yields of potatoes than muriate of potash.

2. Used in the same way, sulphate of potash produces potatoes of better quality than muriate of potash.

3. Potato fertilizers should therefore contain potash in the form of sulphate rather than muriate.

4. A large share of a fertilizer for potatoes should be placed in the drill. This gives larger crops of better quality than spreading broadcast.

5. Treatment with solution of corrosive sublimate of seed potatoes which are moderately scabby will prevent scab, provided the germs of this disease are not present in the soil where the potatoes are planted.

Crimson Clover.

This clover has not proved hardy here, and experiments in its use should be tried upon a small scale.

Japanese Millets.

1. The "barn-yard" variety is worth a trial. Here it has yielded per acre: (*a*) seed, 66.7 bushels, and straw, 11,297 pounds; (*b*) green fodder, 18 tons; or (*c*) hay, 6 tons.

2. The green fodder is superior to good corn fodder in feeding for milk. It makes excellent silage.

Soja Beans.

The medium green variety is a useful crop, whether for feeding green or for silage. It will yield about two-thirds as much gross weight as corn; but is far richer in flesh formers. Silage made by mixing two parts of either corn or barn-yard millet with one of the beans makes a well-balanced feed for cows.

Flat Pea.

Seed was planted in the spring of 1894, but no fodder has as yet been produced.

Sacaline.

Seed planted in the spring of 1895 germinated well, the plants made a good start and promise a large yield of fodder next year.

Hay Caps.

A trial demonstrated their great usefulness in showery weather, and indicates that the Symmes' cap has much to recommend it.

Warming a Stable for Cows.

The increase in milk and butter due to warming a stable was small, and altogether insufficient to pay the cost.

Feeding Hens for Eggs.

1. Vegetable foods, even though furnishing equal amounts of all nutrients and in the proportions considered suitable, are shown to be much inferior to animal foods furnishing the same amounts of nutrients and in the same proportions.

2. Dried meat meal, everything being considered, appears to be superior as a feed for laying fowls to cut fresh bone.

Soil Tests.

Soil tests upon the plan agreed upon in convention in Washington in 1889 have been continued. During the past season we have carried out five such tests: two upon our own grounds, one with rye and the other with grass and clover as the crops; and one each in Concord, Hadley and Shelburne, with corn as the crop. The main points indicated are as follows: —

Grass and Clover.

1. Nitrate of soda, applied at the rate of 160 pounds per acre, is beneficial to the first crop of grass, the average increase amounting to 580 pounds per acre. This result is in line with all results in previous years, both here and elsewhere.

2. This application does not appreciably increase the rowen crop.

3. The potash greatly increases the proportion of clover, and thus considerably benefits the first cut of hay, the average increase this year amounting to 569 pounds of hay for an application of 160 pounds of muriate of potash per acre.

4. The effect of the potash application is most striking upon the rowen crop. This, where timothy, red top and clover are sown, is always chiefly clover. This year there was not rowen enough to weigh except where barn-yard manure or potash had been applied.

5. The phosphoric acid has not much affected either the first or the second cutting.

I would again recommend, for mowings containing mixed grasses and clover, as follows per acre: —

	Pounds.
Nitrate of soda,	150
Tankage of dry fish,	100
Plain superphosphate,	100
Ground South Carolina rock phosphate,	100
Muriate of potash,	150

Mix just before use and spread evenly in early spring.

Corn.

The soil tests with corn this year were all upon land which has been several years under similar manurial treatment. On Mr. Frank Wheeler's farm in Concord the work was begun in 1890, and his crops in the order of succession have been corn, corn, potatoes, grass and clover, grass and clover, and corn (1895).

On Mr. Wheeler's farm this year the average yield of the five nothing plats which have received neither manure nor fertilizer since 1889 was: stover, 3,956 pounds; grain, 40.6 bushels per acre. With muriate of potash alone, at the rate of 160 pounds per acre, the yield was: stover, 2,840 pounds; grain, 59.8 bushels. The average increase on four plats where potash was used, which is apparently due to this fertilizer, is: stover, 1,257 pounds; grain, 21.6 bushels. The average gain due to the use of nitrate of soda is 3.4 bushels of grain, that due to potash (dissolved bone-black) is 2 bushels.

On Mr. West's farm in Hadley the work was begun in 1890, and the crops have been corn, corn, oats, grass and clover, grass and clover, and this year corn. The average yield of the nothing plats per acre this year was: stover, 3,584 pounds; grain, 50.7 bushels. The increase apparently due to the application of potash alone was: stover, 2,900 pounds; grain, 27.4 bushels. The average increase on all plats where potash was used, apparently due to this element, was: stover, 3,200 pounds; grain, 22.8 bushels. Similar averages for

nitrate of soda are: stover, 407 pounds; grain, 9.1 bushels. For phosphate (dissolved bone-black) there has been absolutely no average increase; the crops where this has been applied have been in fact a very little less in every instance except one where it has been used.

On the farm of Mr. Dole in Shelburne the soil test work was begun in 1889 and has continued seven years. The crops in order of succession have been corn, corn, potatoes, oats, grass and clover, grass and clover, and corn (1895). Shelburne is the only place in the State where soil test work with corn as the crop has been carried on which has not indicated potash to be most largely required. The results have been less decisive than in most places, but have indicated phosphate (dissolved bone-black) to be most useful in former years. The past season nitrate of soda appears to have been most useful to the corn crop; but there is strong reason for believing that Mr. Dole, in placing the unhusked corn in the barn, made mistakes in marking the several bunches of material; and I regret to say that the figures are such that I believe deductions therefrom would be unreliable.

Rye.

The acre upon our home grounds which has been seven years under soil test experiments has this year been in winter rye which was sown in October, 1894. In rye we have a crop with a long period of growth which is notable for its ability to extract its food from a poor soil. It was to be expected, therefore, that the differences produced by the fertilizer treatment would be less than with crops such as corn, potatoes and oats. This has been the case; but still the results speak in no uncertain tone. The succession of crops upon this acre has been corn, corn, oats, grass and clover, grass and clover, corn and rye. For the corn, the muriate of potash has been most useful; for the oats and grass, nitrate of soda; for the clover, muriate of potash. This season the average yield of the nothing plats has been: straw, 1,700 pounds; grain, 12.1 bushels. The muriate of potash alone has increased the straw 400 pounds, and the grain 4.1 bushels. On the average, the muriate of

potash has produced the following increases, viz.: straw, 800 pounds; grain, 4.5 bushels. Neither the nitrate of soda nor the phosphate has been as beneficial. The muriate of potash is most beneficial when used with both nitrate and phosphate. The plat where all three were used produced an increase of: straw, 2,480 pounds; grain, 15.4 bushels, as compared with the nothings. Where manure at the rate of five cords per acre has been applied every year for seven years similar increases are: straw, 3,200 pounds; grain, 21.1 bushels. The grain raised on the fertilizer is better than that raised on manure, and in general the size and plumpness of berry were favorably affected by potash.

What White Mustard teaches.

Soon after the rye was harvested the land was ploughed and sown to white mustard, 40 pounds of seed being put in on July 31 without additional fertilizer. The result was a striking object lesson. Germination of the seed was quick and even, but, except on the plats where manure or phosphate (dissolved bone-black), lime and plaster have been applied, there was almost absolutely no growth. On the manure and "complete" fertilizer plats growth was characterized as good; on the plats receiving respectively nitrate of soda and dissolved bone-black, dissolved bone-black and muriate of potash, and dissolved bone-black alone, it was fair. On all others it was poor, though the plats which had received lime and plaster made a little better showing than the others. It will be noticed that where for seven years we have been applying phosphate — even with nothing else — the growth of the mustard was fair to good, while elsewhere there was very little growth; the plants simply vegetated, and then stood still. This result is especially significant upon this land, for, as shown in my description of the soil test with rye, dissolved bone-black has not very materially benefited either corn, oats, grass, clover or rye. On the same land, then, we find corn, clover and rye responding most freely to potash application; oats and grass, to nitrate of soda; and mustard, — a plant of an altogether different order (the turnip and cabbage family), — to phos-

phate. It is believed this object lesson indicates that here, as in England, where the fact has long been pointed out, fertilizers for turnips especially and probably for cabbages also should be rich in available phosphoric acid.

The fertilizers applied yearly in all the soil tests alluded to in my reports are shown in the table below. In some experiments there have been five instead of four nothing plats, as shown in this table, and the numbering of the plats has been different. In other particulars the plan in all has been identical. It has for its object not the production of large crops, but the discovery of facts concerning the special requirements of crops on the soils tested.

Applied Yearly per Acre.

No.	
1.	Nitrate of soda, 160 pounds.
2.	Dissolved bone-black, 320 pounds.
3.	Nothing.
4.	Muriate of potash, 160 pounds.
5.	Lime, 160 pounds.
6.	Nothing.
7.	Farm-yard manure, 5 cords.
8.	Nitrate of soda, 160 pounds. Dissolved bone-black, 320 pounds.
9.	Nothing.
10.	Nitrate of soda, 160 pounds. Muriate of potash, 160 pounds.
11.	Dissolved bone-black, 320 pounds. Muriate of potash, 160 pounds.
12.	Nothing.
13.	Land plaster, 160 pounds.
14.	Nitrate of soda, 160 pounds. Dissolved bone-black, 320 pounds. Muriate of potash, 160 pounds.

Potato Experiments.

Objects.

1. To determine whether the muriate or the sulphate of potash should be used as a source of potash in potato fertilizers.

2. To determine whether fertilizers for this crop should be applied broadcast and harrowed in or put into the drill.

Results.

1. Eight experiments, comparing the sulphate with the muriate of potash, have given an average of 22.1 bushels of merchantable tubers per acre more where the sulphate was the source of potash.

2. The eating quality of the tubers raised when the sulphate has been the source of potash has generally been better than when the muriate was used.

3. Analyses have generally shown that the tubers raised on the sulphate have contained less water and more starch than those raised on the muriate. When this has not been the case, it is believed to have been because the tubers had not properly ripened, owing to the premature death of the tops on account of blight.

4. There has been little difference in the appearance of the tubers raised on the two fertilizers, but the advantage is slightly with the muriate in this respect.

5. The number of bushels per acre in favor of the sulphate has ranged from 4.8 to 82.5 of merchantable tubers. In only one out of the eight experiments has the muriate excelled the sulphate; the difference on total yield was then only 28 pounds per acre.

6. The fertilizer in the drill has generally given larger crops than broadcast application. This has been the case in six out of the eight experiments, the range being from 12.5 bushels to 54 bushels of merchantable tubers per acre in favor of drill application. In the two experiments where broadcast application gave the larger crops, it is believed that the fact was due to natural inequality in the soil.

Details.

These experiments were begun in 1892, and have been continued every year. Each year we have had four plats, which we will call numbers 1, 2, 3 and 4. In 1892 and 1893 these plats were one-sixth of an acre each; in 1894 and 1895, one-fourth of an acre each. The fertilizers have each year been applied broadcast to plats 1 and 2; in the open furrow before dropping the seed to plats 3 and 4. Sulphate of potash has been the source of the potash each year on plats 1 and 3, muriate of potash on plats 2 and 4. The quantities of potash salts employed have been such as to supply equal numbers of pounds of actual potash to plats which were to be compared. Fertilizers supplying equal quantities of nitrogen and phosphoric acid to all the plats have each year been applied.

The experiments of 1892 and 1893 were upon the same land. This land had been in pasture for several years up to 1889. It was ploughed and planted in 1890 and 1891, the crops being white mustard, oats, soja beans and millets. The division into plats in the potato experiments ran across the rows of the two previous years, so that previous cultural conditions had been the same on all the four potato plats. The fertilizers applied in 1890 and 1891 comprised: nitrate of soda, 160 pounds; dissolved bone-black, 320 pounds; and muriate of potash, 160 pounds, per acre in each year. The soil of these plats is a fine medium loam, underlaid by gravel at the depth of about three feet, — an excellent soil, in so far as drainage, warmth and other physical conditions go, for the potato.

The land used in 1894 and 1895 was of the same general character, but with the gravel a little farther from the surface. The same field was used both seasons. This land had, previous to 1890, been used for several years as a pasture. From 1890 to 1893 inclusive it had been used for a variety of hoed crops, all raised on fertilizers. The conditions on all four plats had been alike, but from the nature of our results it is believed that the soil in Plat 4 is inferior in fertility to that in the other plats.

The kinds and amounts of fertilizers used per acre in each of the first three years are shown below : —

FERTILIZERS.	PLATS (1892).				PLATS (1893).				PLATS (1894).			
	1	2	3	4	1	2	3	4	1	2	3	4
Nitrate of soda (pounds), .	160	160	160	160	240	240	240	240	240	240	240	240
Dry ground fish (pounds), .	200	200	200	200	300	300	300	300	-	-	-	-
Dissolved bone-black (pounds),	250	250	250	250	375	375	375	375	375	375	375	375
Sulphate of potash (pounds), .	174	-	174	-	261	-	261	-	211	-	211	-
Muriate of potash (pounds), .	-	174	-	174	-	261	-	261	-	211	-	211
Tankage (pounds), . . .	-	-	-	-	-	-	-	-	240	240	240	240
Dried blood (pounds), . .	-	-	-	-	-	-	-	-	60	60	60	60

In 1895 the same kinds and amounts of fertilizers were used on each plat as in 1894.

Manner of applying Fertilizers.

In every instance all the fertilizers to be used on a plat have been thoroughly mixed just before the seed was to be planted. On plats 1 and 2 each year all of the mixed fertilizers have been evenly spread after ploughing and at once harrowed in. On plats 3 and 4 the mixed fertilizer has been broadly scattered the full length of the open furrow in which the seed was to be dropped. In covering the seed the fertilizer was somewhat mixed with the soil and in part brought above the seed.

Seed used and Manner of Planting.

The variety of potatoes raised has every year been the same, — Beauty of Hebron. In 1892 the seed was from Aroostook County, Maine ; in 1893 it was of our own raising ; in 1894 all except that planted in four rows was from Maine, that in the four rows was of our own growing ; and in 1895 all was from Aroostook County. In 1894 all the seed was treated with a solution of corrosive sublimate, for the prevention of scab. The treatment accomplished the object in view, and will be described later. Each year the seed has consisted of medium to large tubers, and it has been cut into pieces with two strong eyes each. It has been

planted by hand in rows three and one-half feet apart and at a distance of twelve inches in the row. Planting has always been early.

Culture and Appearance while growing.

The land has been harrowed once before the seed was up, and later the harrow or Breed's weeder has been used once or twice more. The work thereafter has been carefully and seasonably performed with one-horse cultivators and hand hoes. During the early part of each of the four seasons the crop growing where the sulphate of potash had been applied was distinctly more vigorous and of a deeper color than that growing on the muriate. This difference was maintained throughout the season, but became less noticeable towards the close of the season of growth.

A similar difference in favor of drill application was always observed, also somewhat less marked towards the close of the season.

The crops of 1892 and 1893 were not affected by leaf blight to any great extent; but those of both 1894 and 1895 were affected, and as a consequence the tubers were less perfectly matured in those years.

Yields per Acre (Bushels).

Sulphate of Potash.

1892.	Broadcast, merchantable tubers, 185.7; small tubers, 10.8. Drill, merchantable tubers, 192.5; small tubers, 13.5.
1893.	Broadcast, merchantable tubers, 290.4; small tubers, 26.4. Drill, merchantable tubers, 344.4; small tubers, 15.0.
1894.	Broadcast, merchantable tubers, 248.0; small tubers, 20.0. Drill, merchantable tubers, 268.4; small tubers, 17.2.
1895.	Broadcast, merchantable tubers, 241.5; small tubers, 15.3. Drill, merchantable tubers, 260.4; small tubers, 14.0.

Muriate of Potash.

1892.	Broadcast, merchantable tubers, 166.6; small tubers, 13.3. Drill, merchantable tubers, 179.0; small tubers, 17.0.
1893.	Broadcast, merchantable tubers, 285.6; small tubers, 15.0. Drill, merchantable tubers, 325.6; small tubers, 21.0.
1894.	Broadcast, merchantable tubers, 254.4; small tubers, 14.3. Drill, merchantable tubers, 186.4; small tubers, 11.3.
1895.	Broadcast, merchantable tubers, 234.0; small tubers, 16.6. Drill, merchantable tubers, 222.7; small tubers, 13.5.

An examination of the figures for corresponding years and plats reveals the fact that the plats receiving sulphate of potash have given the largest yield in every instance except one, viz., broadcast application in 1894. The averages for the two potash salts are as follows: sulphate of potash, per acre, merchantable tubers, 253.9 bushels; small tubers, 16.5 bushels; muriate of potash, per acre, merchantable tubers, 231.8 bushels; small tubers, 15.25 bushels. The average difference amounts to 22.1 bushels of merchantable tubers and 1.25 bushels of small tubers. The difference in cost between the two potash manures amounts to about two dollars per year, the sulphate costing the more.

It should be remarked that since some adverse influence, previously alluded to (not connected with the system of manuring), has affected the crops upon Plat 4 during 1894 and 1895 (drill application of muriate of potash), the above average difference in favor of the sulphate of potash is undoubtedly too large. If we leave this plat out of the calculation, the average difference in favor of the sulphate of potash amounts per acre to merchantable tubers, 13 bushels; small tubers, .3 bushels.

Comparison of the yields on plats receiving the same fertilizers in the different years shows that drill application has given the larger yield in all cases except where drill application of the muriate of potash is compared with broadcast application for 1894 and 1895. As previously stated, Plat 4 (muriate of potash in the drill) has evidently suffered from some inherent inequality in conditions. It therefore seems best to disregard the results of muriate of potash for the seasons 1894 and 1895 in estimating the relative merits of the two systems of application. On this basis the average difference in favor of drill application amounts per acre to 23.5 bushels of merchantable tubers.

Quality of the Crops.

In each year, soon after digging, samples of potatoes grown respectively on sulphate and muriate of potash have been sent under numbers with no other information to several families, who were requested to use them and report whether there was any difference in quality. In 1892 all

reported that the potatoes grown on the sulphate were whiter, more mealy and better flavored than the others. In 1893 they all reported that they could see no great difference between them. In 1894 and 1895 the potatoes grown upon the sulphate were with one or two exceptions reported to be superior to those grown on the muriate, in color, mealiness and flavor. Those reporting otherwise stated that they could see no great difference. In 1894 the head of one family said: "If you have potatoes like No. 1 [grown on sulphate] I would like to get my winter's supply of you; but I would not take No. 2." The season of 1893 was exceptionally hot and dry, as was also that of 1894; but the soil used in 1894 was deeper, and the crop suffered comparatively little from drought.

Moisture and starch determinations in samples of potatoes grown respectively on the sulphate and the muriate have been made every season. The results are shown below for the first three years. They are not given for the present season, because but two samples were taken: one the muriate potatoes, where the fertilizers were put on broadcast; the other the sulphate potatoes, where the fertilizers were put in the drill.

	Sulphate of Potash Potatoes.		Muriate of Potash Potatoes.	
	Water (Per Cent.).	Starch (Per Cent.).	Water (Per Cent.).	Starch (Per Cent.).
1892 Broadcast,	81.09	10.66	81.33	11.99
1892 Drill,	81.56	10.98	81.83	9.45
1893 Broadcast,	75.56	16.98	81.99	12.52
1893 Drill,	74.40	18.44	78.98	14.11
1894 Broadcast,	78.01	15.98	77.53	16.03
1894 Drill,	78.18	15.75	77.68	16.28

It will be noticed that in three out of the six possible comparisons the percentage of water is less and that of starch is greater in the potatoes grown on the sulphate of potash, and that the differences are considerable. In those cases where the results were favorable to the muriate, the differences as a rule are small. The averages for the two fertilizers are: sulphate of potash potatoes, water, 78.11 per cent.; starch,

14.99 per cent. Muriate of potash potatoes, water, 79.86 per cent.; starch, 13.68 per cent.

In those seasons when the muriate potatoes have compared most favorably with the sulphate potatoes, the crop has suffered from leaf blight, and has not therefore ripened as well as in other seasons. It is believed that the experiments indicate that, under average conditions of soil, season and ripening, the potatoes grown on the sulphate of potash will contain less water and more starch than those grown on the muriate.

Examination of the above table shows also that the potatoes grown under drill application of the fertilizers have usually been superior in quality to those grown where the fertilizers have been put on broadcast, containing less water and more starch. The most marked exception is on muriate of potash in 1892; but it appears not unlikely that there was an error in the analysis, since the proportion of water in the drill potatoes is nearly the same as in those grown where the fertilizers were broadcast. It will be noticed that elsewhere the variations in water and starch are about equal in amount, but in opposite directions. When there is more water there is less starch, and *vice versa*. Leaving out the muriate plats for 1892, the averages are: for drill application of fertilizers, water, 78.2 per cent.; starch, 14.9 per cent. Broadcast application of fertilizers, water, 78.8 per cent.; starch, 14.4 per cent.

It is undoubtedly the better ripened condition of the tubers raised under drill application which accounts for their superiority.

Maine compared with Home-grown Seed.

In 1894 Houlton seed in quantity supposed to be sufficient for the entire area under experiment was obtained. It proved insufficient, and the last four rows in each of the four plats were planted with seed grown upon the farm the previous year. These potatoes were raised from Houlton seed. The season of 1894 was, therefore, the first removed from the Maine stock. The results were decidedly in favor of the Houlton seed. The plants started quicker and more vig-

orously, and maintained their superiority throughout the entire season. At harvest the superiority of the crop from the Houlton seed was marked. Each kind was separately weighed on each plat. On Plat 1, Maine seed yielded at the rate of 399.5 pounds more than home seed; on Plat 2, 454 pounds more; on Plat 3, 605.5 pounds more; on Plat 4, 548 pounds more. Per acre the difference in favor of Maine seed amounted to 36.5 bushels, — far more than enough to repay the usual difference in the cost of the two kinds of seed.

Treatment of Seed with Corrosive Sublimate.

In 1894, as the seed to be used showed a little scab, it was all treated with corrosive sublimate solution. Two and one-fourth ounces of corrosive sublimate were dissolved in fifteen gallons of water. The seed was at first washed with a hose, being spread in a shallow inclined trough. After draining, the seed was put into the solution and allowed to remain one and one-half hours. It was then taken out, spread and allowed to dry in the sun, being cut and planted about as soon as it was dry. Corrosive sublimate can be purchased of druggists. It is a dangerous poison if taken into the stomach, but it is not at all dangerous to handle the seed thus prepared. The same solution can be used several times if all the seed cannot be put in at once. Care should be taken to use wooden vessels for the solution, as it will corrode metals. After use the solution should be thrown away in such a manner as to make it certain that animals cannot get hold of it, and where it cannot contaminate wells, springs, streams or ponds.

The treatment is effective in preventing scab where the germs of the disease are not present in the soil, — *i. e.*, on land where scabby potatoes have not been grown for several years. The method was perfected by Professor Bolley of North Dakota, and is fully described in Bulletin No. 9 of that station.

Variety Tests of Potatoes.

Sixty-five varieties of potatoes have been grown during the past season. With few exceptions we procured three pounds of seed of each variety. This seed came from many different sources and was of very varied quality and excellence, both as regards original characteristics and conditions as affected by keeping and transportation. It is not believed that with seed of the different varieties of such unlike character it is possible to make comparisons of permanent value between the varieties. We now have a supply of seed of each sort raised by ourselves under precisely the same conditions. It will be kept and managed alike for all varieties. With such seed to start with, and planted under appropriate conditions, we shall obtain results of value for purposes of comparison.

Meanwhile the following details will be of interest, as illustrating to what an extent the crop is influenced by the seed. The seed of all varieties was cut into pieces of two eyes each, with a very few exceptions where this would have made the pieces extremely small. One row of each sort was planted. Its length was forty feet, the pieces being placed twelve inches apart in the row. The distance between the rows was uniform, three and one-half feet. With the exception of two or three sorts which arrived late, all kinds were planted on the same day. The tops of all were prematurely killed by the blight due to *Macrosporium*, and at about the same time. Full notes have been put on record regarding peculiarities in growth, and the character of the crop harvested. The yield of each has been recorded, — it varies from $24\frac{1}{2}$ to $71\frac{1}{4}$ pounds merchantable potatoes. Six varieties gave a total yield of more than 60 pounds, twenty-three varieties between 50 and 60 pounds, seventeen varieties between 40 and 50 pounds and sixteen varieties between 30 and 40 pounds. The balance gave under 30 pounds total yield. A yield of 60 pounds is equivalent to about 315 bushels per acre. The best variety, then, yielded at the rate of about 368 bushels of merchantable tubers per acre, the poorest at the rate of about 125 bushels.

The soil was a medium, well-drained loam. It received a

dressing of manure in December, 1894, at the rate of 7 cords per acre. We used fertilizers, mixed and applied in the drill at the following rates per acre: —

	Pounds.
Nitrate of soda,	120
Dissolved bone-black,	187½
Sulphate of potash (high grade),	105½
Tankage,	120
Dried blood,	30

Manure alone *v.* Manure and Potash for Corn.

The experiment to test the value of manure and potash as compared with a larger quantity of manures alone for the corn crop has been continued, the past being the fifth successive year of similar treatment. Where manure alone was used we applied at the rate of 6 cords per acre, spread after ploughing and harrowed in. The manure and potash similarly applied have been put on at the rate of 4 cords of the former and 160 pounds of muriate of potash for the latter. The plats, four in number, contain one-quarter of an acre each. The results are shown below: —

Plat No. 1, manure, stover, 1,367 pounds; corn on the ear, 1,227 pounds.
Plat No. 2, manure and potash, stover, 1,223 pounds; corn on the ear, 1,065 pounds.
Plat No. 3, manure, stover, 1,025 pounds; corn on the ear, 1,266 pounds.
Plat No. 4, manure and potash, stover, 987 pounds; corn on the ear, 1,160 pounds.

The manure used was made by cows, that applied to Plat 4 being not as good as that applied to the other plats.

The application made furnished plant food at the following rates per acre: —

FERTILIZERS.	Nitrogen (Pounds).	Phosphoric Acid (Pounds).	Potash (Pounds).
Plat 1, manure alone,	126.4	99.9	232.2
Plat 2, manure and potash,	96.2	67.5	260.8
Plat 3, manure alone,	109.1	100.3	217.8
Plat 4, manure and potash,	83.8	90.4	224.6

It will be noticed that where manure alone was applied considerably more nitrogen and phosphoric acid have been supplied than on the other plats, while the quantity of pot-

ash also is large. It will not be wondered at that after five years of such treatment these manure plats are yielding larger crops than those receiving smaller amounts of manure and potash. The average difference in favor of the manure alone this year is at the rate of 6.8 bushels of grain and 364 pounds of stover per acre, — not enough to cover the larger cost of the manure, as compared with the cost of the lesser amount of manure and the potash. The crop per acre is worth this year $4.17 more when manure alone was applied; but the 6 cords of manure must be reckoned as costing $6.80 more than the 4 cords of manure and the 160 pounds of muriate of potash.

Special Corn Fertilizer *v.* Fertilizer containing More Potash.

Many soil tests in different parts of the State having indicated that fertilizers for corn should contain a larger proportion of potash, an experiment in continuous corn culture was begun in 1891. There are four plats of one-fourth of an acre each, on two of which the "special" furnishes the amounts of nitrogen, phosphoric acid and potash that would be supplied by the application of 1,200 pounds of a fertilizer having the average composition of all leading kinds offered in our markets in 1891.

The materials used are shown below: —

FERTILIZERS.	Plats 1 and 3 (Pounds).	Plats 2 and 4 (Pounds).
Nitrate of soda,	55½	33
Dissolved bone-black,	213	112½
Muriate of potash,	27	75

The yields the past year are shown below: —

Plat 1, "special" fertilizer, stover, 1,092 pounds; grain on ear, 1,112 pounds.

Plat 2, fertilizer richer in potash, stover, 1,199 pounds; grain on ear, 1,055 pounds.

Plat 3, "special" fertilizer, stover, 958 pounds; grain on ear, 1,220 pounds.

Plat 4, fertilizer richer in potash, stover, 1,100 pounds; grain on ear, 1,190 pounds.

Computed to the acre and the grain in bushels, the averages are: "special," stover, 4,100 pounds; grain, 58.3 bushels; fertilizer richer in potash, stover, 4,598 pounds; grain, 56.1 bushels. Here, as in the comparison between "manure" and "manure and potash," there is rather more stover and a little less grain where the greater amount of potash is used. The "special" produces this year, per acre, 2.2 bushels more grain and 498 pounds less stover than the combination with more potash. The increase in stover due to the greater amount of potash is worth about $1.10 more than the increase in grain due to the "special;" hence, as the fertilizer richer in potash costs about $2.52 less per acre than the special, there is a net advantage amounting to $3.62 per acre in favor of the former.

It is believed that by *the introduction of plants of the clover family* (*nitrogen traps*), which from experiments here and in many other places we are justified in concluding would grow more luxuriantly where the larger amount of potash has been used than where "special" has been applied, the advantage of the larger potash application could be much increased. An effort to demonstrate this fact has been made in each of the seasons of 1893 and 1894 by sowing *crimson clover* on one-half of this acre; but, owing to the *winter-killing* of this *clover* both years, the effect, though favorable, is small. Per acre the yields have been: where crimson clover was sown, stover, 4,512 pounds; grain, 58.6 bushels; without clover, stover, 4,186 pounds; grain, 55.9 bushels. The clover has been sown in the standing corn in July, and turned under just before planting the corn the following spring.

Hill *v.* Drill Culture for Corn.

On plats 1 and 2 in both the corn experiments just described the corn was planted in drills; on plats 3 and 4, in hills. We have left equal numbers of plants to a plot in both systems. All rows were three and one-half feet apart; hills with three plants each, three feet apart; plants in the drill one foot apart. In both experiments the hill system has produced rather more grain and less stover than the drill. The average figures per acre are as follows: manure

v. manure and potash, hills, stover, 4,024 pounds; grain, 60.7 bushels; drills, stover, 5,180 pounds; grain, 57.3 bushels; "special" *v.* fertilizer richer in potash, hills, stover, 4,116 pounds; grain, 60.3 bushels; drills, stover, 4,582 pounds; grain, 54.2 bushels. Averaging both experiments, the drill system produced the more valuable *total* crop.

White mustard as a crop for nitrogen conservation has been sown on one-half of the acre of corn where *manure alone* is compared with *manure and potash* every year since 1892. The mustard seed is sown in the standing corn in July, at the rate of 24 pounds per acre. Its growth from year to year has varied greatly, as in very dry seasons it does not start well. The past two seasons the growth has been light. It is ploughed in late in the fall. The beneficial effect is apparent, and is doubtless largely due to the fact that the mustard, which grows till very late in the season, prevents in a measure the loss of soluble nitrogen compounds by leaching. It acts as a *nitrogen conserver.* The averages this year per acre are as follows: with white mustard as a green manure, stover, 4,828 pounds; grain, 61.7 bushels; without the mustard, stover, 4,376 pounds; grain, 56.3 bushels. *Gain by green manuring,* stover, 452 pounds; grain, 5.4 bushels.

Japanese Millets.

Panicum crus-galli.

The Japanese millet of this species, which I propose to call "barn-yard" millet, because it is of the same species as the common barn-yard grass, has been very thoroughly tried the past year, for seed, for green fodder and for hay.

For Seed. — For seed purposes we raised about three-quarters of an acre. The land, in very moderate fertility, was manured at the rate of 6 cords per acre of good manure in December, 1894, and arter ploughing this spring the following materials per acre were spread on (mixed) and harrowed in: nitrate of soda, 100 pounds; dissolved bone-black, 200 pounds; and muriate of potash, 100 pounds. The seed was put in with a small seed sower, in drills fifteen inches apart. It was wheel-hoed, and kept free from weeds. The

crop was very even, averaging seven feet in height. The yield was at the rate per acre: straw, 11,297 pounds; and seed, 66.7 bushels.

For Green Fodder and the Silo. — Several pieces of an acre or more each were sown for feeding green or for the silo. The earliest, sown broadcast about the middle of May on rich land, one peck of seed to the acre, averaged about six feet in height and produced over 15 tons per acre. This was cut from day to day, beginning before the millet had blossomed. Another field of about an acre, sown the last of June, yielded at the rate of rather over 18 tons per acre. Another field, sown July 26, after a crop of hay was removed, yielded about 12 tons per acre. The crop of the two last fields was put into the silo. That cut from day to day and fed green to cows was much relished. Its superiority to well-eared flint corn fodder was very apparent. Cows with both before them always take the millet first; they consume it without waste, while they are apt to leave a part of the stalks of the corn as it approaches maturity. In alternating this feed with corn fodder, the cows invariably increased in milk when put upon the millet and fell off when changed to corn.

It has been ensiled with soja beans, — about two parts by weight of the millet and one of the beans. This combination makes very superior silage.

For Hay. — A more extensive trial of this millet for hay has been carried out this year than ever before. It is coarse and difficult to dry. I have always felt that these qualities would render it undesirable as a crop for hay. We have, however, cured it successfully this year, mostly in small cocks, as clover is often cured; and the result is encouraging. The hay is coarse, but is freely eaten by horses, being preferred to a good sample of timothy, red top and clover mixture. The yield of the millet is very large, having on good land amounted to 6 tons per acre of well-cured hay. It will produce a fair second cutting if sown early in May and cut when in blossom.

The soil best for this millet is one that is rather retentive and rich. It stands up remarkably well, notwithstanding its great height. From a peck to a half bushel of seed, accord-

ing to the richness of the land and the season of sowing, is enough. Less seed the richer the land and the earlier the season should be the rule. This millet will not endure drought well, except it be sown early in retentive soil. From early corn-planting time to about July 1 will usually be the limits of season for profitable sowing.

Panicum miliaceum.

This species, some other varieties of which are known as "panicle," "broom-corn" and "French" millets, I shall speak of hereafter as "Japanese panicle" millet. It has been grown upon a small scale for seed the past year. The area was a little less than a quarter of an acre. It received at the rate per acre: nitrate of soda, 175 pounds; dissolved bone-black, 320 pounds; and muriate of potash, 175 pounds, — all mixed, sown broadcast and harrowed in. The seed was thinly sown in drills, fifteen inches apart, and cultivated and kept free from weeds. The yield was at the rate of: straw, 5,856 pounds; seed, 34.1 bushels per acre. This variety is liked for fodder by some who have tried it; but I regard it as inferior to the barn-yard millet for that purpose. The seed is valuable for poultry and birds.

Panicum italicum.

The Japanese variety of this species has been grown for seed; soil, manure and fertilizers, as well as manner of planting and care, the same as for "barn-yard" millet. It yields at the rate per acre: straw, 3,836 pounds; seed, 66.4 bushels. This variety is of value for fodder, but I prefer the "barn-yard" variety.

Variety Tests with Millets.

Twenty-seven varieties of millet have been grown upon a small scale, for purposes of comparison. With three exceptions four rows, each thirty feet long, were planted. Of these, owing to our inability to procure enough seed, we had but one or two rows. Careful observations have been put on record, but only for preliminary purposes, as the scale of work was small. The gross yield varied from 11 to 49

pounds. Six varieties yielded above 40 pounds; six, from 30 to 40; seven, from 20 to 30; and eight, between 10 and 20 pounds. Four varieties, "White French," "broom corn," "hog" and "California," appear to be identical. The "pearl" millets are too late to perfect seed here. The Japanese (*italicum*) excelled either the "golden" or the "golden wonder."

Variety Tests with Turnips.

Preliminary tests have been made with thirty-two varieties of turnips. There were among the number numerous kinds which appear to differ from others only in name, and there was a wide difference in yield and quality. Further work must be done before reporting details.

Soja Beans.

Early White. — Grown for seed; area, .49 acre; yield, $18\frac{1}{4}$ bushels per acre. This variety is too small for fodder. It ripens as surely here as our common field corn. The beans ground are slightly superior in feeding value, for milk, cream or butter, to cotton-seed meal, but the yield is rather small. The cultivation costs about the same as that of corn for equal areas. The vines shed their leaves before the pods are ripe, and hence they have very little feed value. The manurial value of the straw is about $2.40 per ton.

Medium Black. — This variety, though later than the above, has ripened here every year for the last seven. It has been grown this year both for seed and for the silo. For seed: area, .6 acre; yield, 14 bushels per acre. This variety rusted somewhat this year. We put the product of .45 acre into the silo, mixed with about two parts by weight of barn-yard millet. The yield was at the rate of 12,922 pounds per acre. This crop stood about three and one-half feet high. It is better for fodder than the early white, but appears to be much inferior to the medium green variety for that use.

Medium Green. — This variety is a little later than the last. It has ripened every year until this without injury.

This year it was somewhat injured by frost; but we have nevertheless secured a very good crop of seed. Area for this purpose, .6 acre; yield, 14 bushels per acre. We put the product of .45 acre into the silo with millet, as just described. The crop averaged nearly four feet in height, and was heavily podded. The yield was 20,644 pounds per acre. I look upon this as a very valuable fodder variety, either for feeding green or for the silo. It is a rich nitrogenous feed, and (of great importance) it can take much of its nitrogen from the air. Its roots here are very thickly covered with tubercles containing the bacilli which give it this power. For comparison, I give figures showing the analysis of this bean fodder and those for corn fodder: —

	Per Cent.
Medium green soja bean, pods formed, but not hardened, dry matter,	30.16
Longfellow corn fodder, ears glazed, dry matter, ...	27.81

Composition of Dry Matter (Per Cent.).

	Protein.	Fat.	Cellulose.	Carbo-hydrates.
Medium green soja bean, . .	19.35	3.87	23.51	40.30
Longfellow corn fodder, . .	9.79	3.26	18.27	63.11

The protein is classed as a flesh former, the other substances above named are fat and heat producers. The flesh formers and the fat of fodder are the most valuable of these constituents, pound for pound; the cellulose or fibre is the least valuable. On the farm here our average yield of corn fodder is about 16 tons per acre, while the green soja bean gave this year a little over 10 tons. The amounts of the different food constituents produced are as shown below: —

Food Constituents per Acre (Pounds).

	Flesh Formers.	Crude Fat.	Fibre.	Fat and Heat Producers.
Green soja bean, ...	1,167.2	233.4	1,418.1	2,430.9
Longfellow corn, ...	871.3	290.1	1,626.0	5,616.8

It will be noticed that the bean produces about 300 pounds more flesh formers than the corn, but that the latter gives us over 3,000 pounds more fat and heat producers. These consist chiefly of starch and sugar, both of which are easily digested and valuable foods. The differences in crude fat and in fibre are much smaller, but the balance is slightly with the corn. There can be no doubt, then, that the latter produces the more valuable crop of the two, and the cost of production for equal areas does not differ very materially. In three respects, however, the bean is superior to the corn; viz., (1) it can draw much of its nitrogen from the air; (2) the bean stubble and roots probably have greater manurial value than those of corn; and (3) the bean, being so rich in flesh formers, may take the place of such concentrated foods as cotton-seed meal, linseed meal, gluten meal, etc.

Silage made from either barn-yard millet or corn and medium green soja bean, in the proportion by weight of about two parts of either of the two former to one of the latter, makes a perfectly balanced ration for milch cows, without grain or other feed of any kind. It is not believed that it would be advisable to feed altogether upon this material, for cows like variety, and it is possible that continuous use of a fermented feed like silage would have a prejudicial influence upon health. A combination of such silage and clover hay or clover rowen — about two parts of the silage to one of the hay by weight — would, I believe, give good returns in milk. This particular system of feeding has not yet been tried here.

Miscellaneous Crops.

We have had under trial a number of miscellaneous crops, including *Cystisus proliferous albus*, a new fodder plant sent on for trial by J. M. Thorburn & Co.; yellow millo maize, from the United States Department of Agriculture; two varieties of dent corn, from South Dakota; black barley; spring wheat, from South Dakota; horse bean; sacaline; flat pea and the mummy field pea. None require extended notice at present.

Cystisus (no common name is given) vegetated slowly and made a slow growth. It appears to be hardy, remain-

ing green until November 5, when it was three feet high, with small and woody stalks. It has produced no fodder as yet.

Yellow millo maize is a sorghum, and, like all other varieties of this species, grows slowly at first. Planted with corn, it was eight to twelve inches high when corn was thirty. It has the reputation of enduring drought well; but our seasons are not long enough for it, and I consider it of no value as a fodder crop here.

One of the dent corns from South Dakota appears to be a very valuable sort. It is a white variety. The seed of but two ears was planted, and upon soil of very ordinary fertility. The stalk is short and small, the ears large and deep kernelled, the variety early. The yield was at the rate of 89.6 bushels of grain to the acre.

The *spring wheat* and *black barley* did poorly, rusting and giving very small returns.

Horse Bean. — We received one peck of seed from a dealer in Montreal. It was planted in drills eighteen inches apart, in deep, clayey, rich soil, on April 29. The growth was vigorous and healthy, but few pods formed. The height was from four and one-half to five feet. It was cut from day to day, beginning July 17, and fed to cows, being highly relished. The total weight was 2,035 pounds, or at the rate of a little over 12 tons per acre. This yield of so highly nitrogenous a fodder makes it of possible value.

Sacaline. — Seed was procured of Gregory & Son of Marblehead, and sown in a bed in the open air April 23. The germination was slow, but good. Early in July the little plants were taken up and reset about three inches apart each way. About the middle of August plants were set in the field three feet apart each way. Two widely different soils were selected, — one a heavy, rich, moist loam, the other a dry, sandy loam. The plants in both soils lived well, and those in the moist, rich land made considerable growth, though not enough to be worth harvesting. A few stems cut and offered to cattle were freely eaten. The plant is perennial, and should next season produce considerable fodder which may prove valuable for green feed or for the silo.

Flat Pea. — The past is our second season with this much-lauded fodder plant. The germination last year was slow and imperfect. This year the plants have been gathered upon a lesser area, some being taken up to fill vacancies on the part left. The soil is light and dry. We have in the two seasons been at a very considerable expense, and as yet have no fodder; but, as the plant is perennial, this may come later. It is hardy with us upon light soil.

Mummy field peas are larger than the common Canada field pea, and about one-fourth to one-half more seed should be sown. We used at the rate per acre of one bushel of each with two bushels of oats for fodder. The mummy variety was not thick enough. In one respect it appears superior to the Canada; viz., it lodges less. This difference may, however, have been in part due to the fact that the mummy variety was the thinner in the field. The yields of the two fodder mixtures, as determined by calculation based upon small equal areas, were: oats and Canada pea, 21,760 pounds, and oats and mummy pea, 19,040 pounds, per acre.

Trial of Hay Caps.

Three kinds of hay caps have been subjected to careful comparative tests. The kinds tried were the Symmes' paper-board cap, oiled cotton, and cotton impregnated with tannin. The first was not fastened in place, its weight and construction rendering this less necessary than for the other forms. It, however, sometimes blew off in high winds. The others were fastened on by means of pins attached to cords at the corners.

Three trials were made, two with clover rowen which had been dried one day, and one with barn-yard millet which had been dried three days. After the caps were put on the first trial continued seven days; the second, two days; the third, with millet, seven days. During each trial there were one or more showers. In every trial the use of the cap was very beneficial. The paper cap excluded the rain most perfectly, and the hay in each trial came out in best condition. There was not much difference in the condition of the hay under the other two kinds of caps. As the

Symmes' paper cap can be put on fully twice as rapidly as the forms requiring fastening, it appears to be most useful. Its weight is an objection, and of course we are not yet able to report upon durability.

Experiment in Warming a Stable for Cows.

This experiment was continued during the winter of 1894–95, beginning December 18 and continuing until March 8. It will be remembered that our stable has two similar wings, one piped for hot-water heating. We aimed to maintain a temperature of about 55° F. in the warm stable. The other, of course, varied with the weather; but, as both stables are thoroughly constructed, even the "cold" side was seldom excessively cold. Six cows were used in the experiment, three on each side. We divided the time into four periods of equal length. At the close of the first period the cows changed stables. Here they were kept for two periods, and were then changed again. In this way we equalized conditions for the two stables. Between periods, when a change in the position of the cows was made, we allowed an interval of one week, that the animals might become accustomed to and under the influence of their new quarters before the records were begun.

The apparent influence of the warm stable upon milk and butter fat production is small. On the average, there is rather more milk and butter fat in the warm stable. The most certain effect brought out by our experiments is the lowering of the percentage of fat in the milk in the warm stable. The increased product will not nearly pay the cost of heating the stable.

With moderate artificial heat better ventilation can be secured, without making the stable too cold for the comfort of its occupants, than is possible without artificial heat. This should have an ultimate influence upon health; but the tuberculin test, as well as physical examination, indicated all our animals to be in perfect health at the close of the experiments, hence we as yet have nothing conclusive upon this point.

Poultry Experiments.

These have been upon a small scale, on account of location and limited equipment. We have had four coops of laying fowls, raised in 1894. There have been from fifteen to nineteen hens in a house. The houses are exactly alike in construction, each with nesting and laying room, ten by twelve feet; and scratching shed, eight by ten feet in size. The hens were of two breeds, — light Brahma and barred Plymouth Rock.

We have confined our attention to two points: —

1. The relative value for egg production of vegetable as compared with animal substances for furnishing the greater part of the albuminoids and fats of the food.

2. The relative value for egg production of animal food in the form of dried "animal" or "flesh" meals, as compared with cut fresh bone.

1. Vegetable v. Animal Albuminoids.

Two experiments have been carried out: one extending from Dec. 9, 1894, to Feb. 12, 1895; the other from June 1 to Oct. 31, 1895. The first experiment began when the fowls were pullets, hatched in May; the second includes a considerable proportion of the time occupied in the annual moult. These facts account in part for the small egg production. During the summer experiment the fowls had the run of small grass yards.

The material used in the first experiment to furnish the vegetable substitute for animal food was soja-bean meal. This is an exceptionally rich vegetable substance, in composition excelling meat meal, as will be seen from the figures below: —

Composition of the Dry Matter, Soja-bean Meal and Meat Meal (Per Cent.).

FOOD.	Flesh Formers.	Fat.	Heat and Fat Formers.
Soja-bean meal,	34.37	16.38	45.22
Meat meal,	35.98	8.31	–

Moisture: soja-bean meal, 11.61 per cent.; meat meal, 13.68 per cent.

In the second experiment linseed and cotton-seed meal were used as the vegetable substitutes for animal foods.

In both experiments the fowls received a variety of foods, but the nutritive ratio was always kept substantially the same for the two coops under comparison. In the first experiment the ratio was one flesh former to four and one-half fat and heat formers; in the second it was one to four and seven-tenths. The foods used in the first experiment, in addition to the soja-bean meal and meat meal, were: cut alfalfa, wheat, oats and middlings in one coop; in the other, boiled potatoes, ground clover, wheat, wheat middlings and cut bone.

In the second experiment the supplementary feeds were: wheat, oats, bran and middlings for the vegetable coop; and wheat, oats, wheat meal, bran and linseed meal for the animal food coop.

Both coops had pure water, artificial grit and ground oyster shells always before them; and all other conditions were made as nearly as possible alike.

The result in both experiments has been favorable to the animal food, as shown by the following summary: —

Vegetable v. Animal Foods for Hens.

FOOD.	Duration of Experiment (Days).	Daily Cost per Fowl.	Number of Eggs.	Water-free Food per Egg (Pounds).	Cost per Egg.
Vegetable food, first coop, .	64	$0 0021	11	23.830	$0 3410
Vegetable food, second coop,	153	0027	400	.917	0150
Animal food, first coop, . .	64	0024	79	3.554	0550
Animal food, second coop, .	153	0033	622	.773	0115

In the above estimate of cost no charge is made for labor and no allowance for the droppings. The production of eggs is, of course, very small, even in the best period; but it should be remembered that, at the very time when hens always lay most freely, our fowls were taken out of this experiment for breeding purposes, viz., from February 12 to June 1.

The results are, however, decisive against the vegetable food and in favor of the animal in so far as effect upon egg

production is concerned. The fowls receiving animal food were, moreover, in much better condition at the close of these experiments than the others.

2. Dried Animal or Meat Meal compared with Cut Fresh Bone.

There were two experiments. The general conditions were the same as in the comparison of vegetable and animal foods. The nutritive ratio was nearly the same in coops compared. A variety of foods was supplied; artificial grit and oyster shells were given *ad lib.* The results are shown below: —

FOOD.	Duration of Experiment (Days).	Daily Cost per Fowl.	Number of Eggs.	Water-free Food per Egg (Pounds).	Cost per Egg.
Dried meat meal, first coop, .	64	$0 00266	185	1.185	$0 0170
Dried meat meal, second coop,	153	00280	417	1.051	0152
Cut fresh bone, first coop, .	64	00248	163	1.154	0170
Cut fresh bone, second coop, .	153	00300	444	.978	0143

These results are rather indecisive, as in one experiment the meat meal and in the other the cut fresh bone gave the better results, as measured by egg production. The condition of the fowls receiving the meat meal has, however, been uniformly better than in the other coops. There has been no diarrhœa. In the second experiment, two hens in the cut-bone coop died; and at the close of this experiment the fowls which had been receiving meat meal were nearer through moulting than the others.

Of course it is possible that the bone was not used in the best practicable manner; but it appears to be exceedingly difficult to secure an even distribution of this food. Some hens almost invariably secure more than their share, and this is equally true, whether the cut bone be scattered or mixed in a mash. The result is frequent diarrhœas. The meat meal, on the other hand, can be evenly mixed in a mash, so that all fowls share alike, as it cannot be picked out. Our results indicate that it is a safer feed than the bone; it is also a much cheaper feed; and, if it will give practically as many eggs, it is to be preferred. This experiment will be repeated.

REPORT OF ENTOMOLOGIST.

CHARLES H. FERNALD.

During the past year a great deal of time has been devoted to arranging and supervising experiments on the gypsy moth, and also to preparing, in conjunction with the field director, Mr. Forbush, a full report on this insect. The Commonwealth of Massachusetts has spent and is still spending large sums of money for its destruction, and in protecting the farmers of the State from the ravages of this notorious pest. It seemed wise and proper to devote much time and attention to the study of the gypsy moth and its habits, for the purpose of discovering the best and most economical methods for its destruction.

A large amount of time has been spent in preparing a complete account of our *Crambidæ*, which appears with six colored plates and structural details elsewhere in this report. This paper is designed to give all known scientific and practical knowledge that we possess about these insects, and it is hoped that the illustrations, in connection with the descriptions, will enable our farmers to determine any of these insects, and when they are found in large numbers in their grass lands, as often occurs, they may be better able to combat them.

Bulletin No. 28 was prepared by this division, and contains descriptions and illustrations of two species of canker worms, the army worm, the red-humped apple-tree caterpillar, the antiopa butterfly, the currant stem-girdler, the imported elm-bark louse and the greenhouse orthezia, together with methods of holding them in check.

On the 29th of March, my attention was called to some scale insects on several young plum trees on the grounds of

the horticultural department of the Massachusetts Agricultural College, which proved to be the dreaded San José scale. These trees, according to the record books, came from the J. T. Lovett Company, Little Silver, N. J., in the spring of 1894.

Wishing to determine whether any of these insects had survived the winter, I had two of the trees taken up and set out in the cold part of the insectary greenhouse, and the remaining infested trees were burned. Scales appeared on the growth of the previous year, so that the insects succeeded well at least during the summer of 1894. On June 10, live scales were observed on the trees transplanted to the insectary greenhouse, and on the 14th the young were swarming all over them, and even extended to some small apple trees growing near in the same part of the greenhouse. As this seemed to settle the question of their ability to survive our winters here in Amherst, or at least the winter of 1894–95, which was an average one, I had all these trees very carefully burned, to prevent any further spreading of the pest. As soon as it was discovered that the San José scale had been received here on nursery stock from outside of the State, I feared that other nurseries might have become infested in a similar manner, and therefore I sent Mr. Lounsbury, who was my assistant at that time, to different nurseries to look for them. He reported that on April 19 he found the San José scale on two plum trees, two pear trees and a rose bush in Roslindale, Mass. The plum trees were badly infested with living scales, while the pear trees and rose bush were but slightly so. The scales occurred on all parts of the trees, but were the least numerous on the new growth. The pear trees had been on the grounds for three years and the plum trees two years. Mr. Lounsbury was informed that these trees were obtained from a local agent at West Roxbury, who claimed to have purchased them from the Shady Hill nursery, Bedford, Mass. On April 23 Mr. Lounsbury visited the Shady Hill nursery, and found the San José scale alive in large numbers on several different varieties of apple trees. Mr. Kohler, in charge of the nursery, told him that these trees were brought from the Cambridge nurseries, where they had been growing three or four years.

The Cambridge nursery was then visited, and pear, peach and apple trees were found infested with the scale, and many of the worst-infested trees were dead. As no stock had been added to this nursery for three years, these trees must have been infested at least that length of time. I have not been able to learn from what source the stock in this Cambridge nursery was obtained.

On July 9 I received a twig of an apple tree from Mr. W. W. Rawson, with the request to inform him what the matter was with it. An examination showed that it was infested with the San José scale. Further correspondence revealed the fact that the twig came from an apple tree in the orchard of Mr. E. E. Cole, in the town of Scituate. Mr. Cole wrote me that the orchard contained ninety trees that were set out three years ago. It is situated in a protected spot, with trees on three sides, and is within two miles of the ocean in a direct line. He also wrote me that the trees were received from Mr. Rawson, who informed me that he obtained most of his nursery stock of that description from the Shady Hill Nursery Company.

It is therefore probable that the Shady Hill nurseries received infested stock from some outside nursery, possibly in New Jersey, and have unintentionally become a centre of infection for orchards in the eastern part of this State. To what extent this pest has become distributed through the State it is impossible to say, but that it is able to live and destroy fruit trees in some if not in all parts of the State seems evident. A complete account of this insect was prepared and published with illustrations in the Massachusetts Crop Report for August.

The correspondence is steadily increasing, and many letters about injurious insects are received from nearly every part of the State. Most of these letters call for information about such insects as are causing more or less damage, and it is very rarely that we are called upon to give information about insects that have merely excited the curiosity of the sender.

The elm-leaf beetle appears to be rapidly spreading in the State, and we have been called upon frequently during the year for information about this beetle. A bulletin will soon

be prepared on this and several other insects, which are so numerous as to cause much damage in various parts of the State, and about which we receive frequent inquiries.

Our studies on the cranberry insect are progressing as fast as other matters will permit, and it is our intention to prepare as complete a report on these insects as possible, at some future time.

REPORT OF HORTICULTURIST.

SAMUEL T. MAYNARD.

Owing to the recent separation of the horticultural and botanical divisions, the report from this division will partake more of an outline of the work to be undertaken than of results obtained.

The work has been carried on much in the same lines as in previous years. The season, up to the time of the severe hail storm, September 11, had been one that promised more than the average for the growth and perfection of nearly all of the crops under cultivation, and insects and fungous pests were not more than usually abundant. On September 11 one of the heaviest hail storms ever known in this section occurred, which resulted in almost the total destruction of the crops not matured at that time.

Protection of Crops from Insects and Fungous Diseases.

In growing the various fruit, vegetable and other crops, it is found necessary to protect them from insects and fungous pests, and much work has been done in using and testing insecticides and fungicides.

The lines of work pursued have been for the most part confined to testing large and small fruits, especially new varieties of promise; the various insecticides and fungicides recommended for their power to protect from common insect and fungous pests; all new varieties of vegetables and flowers sent in for trial by the originator or introducer, and some of the most promising obtained in the open market. Many new and promising ornamental trees and shrubs have been planted for comparison, and many new varieties of

flowering and bedding plants have been added to the collection under glass. Comparisons have also been made respecting the effects of various kinds and different combinations of fertilizers upon growing crops.

Equipment.

This division requires for comparison a large number of standard varieties. These are already provided in the college orchard, vineyards, garden and greenhouses. In this work of comparison the most careful, painstaking observation is demanded. Suitable land is also required for the best growth of each crop, and a great variety of implements and tools for cultivating the same. Each different process requires its own tool, and facilities for storage must be provided, in order to market to the best advantage.

Varieties of Fruits.

The varieties of fruits now under observation on the college grounds may be enumerated as follows: —

Apples, 150 varieties; pears, 67; peaches, 49; plums, 103 (including types of all the groups according to the latest grouping); apricots, 13; nectarines, 2; quinces, 8, and many seedlings; cherries, 33; grapes, 143, and more than 500 seedlings not fruited; currants, 20; gooseberries, 17; red raspberries, 25, and many seedlings of the Shaffer type; black-cap raspberries, 31; blackberries, 21; strawberries, 157 named varieties, and about 600 seedlings from carefully crossed and selected varieties. Besides the above, there are growing many of the newer fruits, like the Japanese wineberry, May berry, salmon berry, Logan berry, strawberry-raspberry, Rocky Mountain cherry, sand cherry, June berry, Japanese walnut, Spanish, Japanese and hybrid chestnuts.

Spraying Outfit.

Machine Pumps. — The expense of applying insecticides and fungicides by hand pumps has been so great in the past that most of the work during the season just elapsed has been done with the Victor machine pump, resulting in a great saving of time, the power being applied by gearing attached to the

wheels. This pump was worked very satisfactorily with all growths except large trees, where the time required to spray a single tree is so great that the power acquired by the motion of the wheels becomes exhausted before the tree is thoroughly sprayed in every part. This has necessitated driving around the tree several times, or working the pump by hand. Even with this pump, however, tall trees cannot be readily reached, and to obtain more reliable and more constant power a *steam pump* is being constructed, which is guaranteed to carry three streams through the ordinary three-quarter-inch hose at one time, fifty feet high. This will enable the hose to be taken into tall ornamental trees, and the work to be done more effectually, economically and quickly than by any of the ordinary hand or machine pumps. The pump, engine and tank, holding one hundred to one hundred and fifty gallons, will be compactly mounted on a low truck, with wheels having six-inch tires and bolster springs, that it may be drawn over soft or rough ground with the least jolting possible. The weight of engine, pump, tank and truck is expected not to exceed eight hundred pounds, and when the tank is filled to be easily drawn by two horses.

Vegetables.

During the past season the following number of varieties of vegetables has been tested: —

Asparagus, 3 varieties; artichoke, 2; beans, 11; beets, 6; Brussells sprouts, 2; carrots, 6; cabbages, 8; cauliflowers, 5; celery, 10; cucumbers, 6; sweet corn, 7; dandelion, 2; endive, 2; kohl-rabi, 2; lettuce, 5; onions, 6; parsley, 2; peppers, 4; egg-plant, 6; peas, 7; pumpkins, 4; radishes, 6; squashes, 11; spinach, 3; parsnips, 6; tomatoes, 16; rhubarb, 4.

Seed Testing.

Seed testing is of the greatest practical importance to the farmer, market gardener and the florist, but at the same time it is most difficult so to conduct it as to obtain entirely satisfactory results. It will be hardly possible, with the present equipment, to make trial of the seeds of all of the varieties of farm and garden crops put upon the market by different

growers, and it is planned to procure only those that are most largely grown and the new promising kinds. In the outline for this work it is proposed to make at least three tests of each variety under each of several methods adopted in the greenhouse, and three in the field at different dates, yet under as nearly the same conditions as possible. It is also proposed to test the quality of the products of each under ordinary field culture. In this way it is hoped to arrive at some definite conclusions respecting the comparative value of each variety for general cultivation, and the dependence of the crop on the quality of the seed.

Plants in the Greenhouses.

In these houses most of the promising new varieties of plants grown by the commercial florist are tested as they are introduced. The following is a partial list of the number of varieties tested : —

Carnations, 18 varieties ; chrysanthemums, 30 ; coleus, 14 ; begonias, 31 ; bulbs, 55 species and varieties ; geraniums, 24 ; roses, 12 ; violets, 3, etc.

REPORT OF METEOROLOGIST.

LEONARD METCALF.

Aside from the mere routine work incident to keeping up the daily meteorological records and observations, the work of the department has been confined chiefly to the compilation of data accumulated at this observatory during the past seven years. The records of this station, from the time of its foundation in 1889 to date, have been compiled and summarized, and tables have been prepared showing the maximum, minimum and mean observations. These results will probably be published in the form of a special bulletin early next year.

But few new instruments have been added to our equipment, — one or two new clocks for the self-recording instruments replace the old ones in case of emergency or mishap, and thus preserve the continuity of the records; and a new signal service standard Fahrenheit thermometer, for comparing and verifying the accuracy of the temperature indications of the wet and dry bulb thermometers, and the maximum, minimum and self-recording thermometers.

The ozone observations have been discontinued, owing to their uncertainty and unreliability. The amount of rainfall will henceforth be recorded on top of the tower, as on the ground, by means of a United States signal service standard rain gauge (as well as by the self-recording gauge), in order that the tower readings may be perfectly comparable with those of the ground.

REPORT OF CHEMIST.

DEPARTMENT OF FOODS AND FEEDING.

Conducted by J. B. Lindsey, with the assistance of C. S. Crocker, B.S., chemist; E. B. Holland, B.S., chemist; G. A. Billings, B.S., assistant in feeding department.

Part I.

Laboratory Work.

(*a*) Fodder analyses.
(*b*) Water analyses.
(*c*) Dairy products.

Part II.

Feeding Experiments and Dairy Studies.

(*a*) Chicago gluten meal *v.* King gluten meal.
(*b*) Chicago gluten meal *v.* Atlas meal.
(*c*) Composition of cream from different cows.
(*d*) Wheat meal *v.* rye meal for pigs.
(*e*) Salt hays and meadow hay (values for feeding).

Part I.

(*a*) FODDER ANALYSES.

We have received and analyzed for farmers during the year 49 samples of various grains, by-products and coarse feeds. We publish here only those having any particular interest, or that have more recently appeared in our markets. For analyses of all such feeds see complete table at the end of this report.

All cattle feeds have been divided into five groups of substances: —

1. *Crude ash* means the mineral ingredients contained in the plant or seed, such as lime, potash, soda, magnesia, iron, phosphoric acid, sulphuric acid and silicic acid. The ash serves to build up the bony structure of the animal.

2. *Crude cellulose* is the coarse or woody part of the plant; straws and hays contain large quantities, while in the grains and most by-products but little is present. It serves to produce vital energy and fat.

3. *Crude fat* includes the fats, waxes, resins, etc. It serves the same purpose as cellulose, but furnishes two and one-half times as much vital energy.

4. *Protein* is a general name for all nitrogen-containing bodies found in plants. It might be called "vegetable meat." It is a source of energy, possibly a source of fat, and *is the only source of flesh.*

5. Nitrogen-free extract consists of starch, sugars and gums. These substances produce energy and fat. Cellulose and extract are termed carbohydrates.

The grains are valuable chiefly for their extract matter, protein and fat. They contain very little cellulose. The estimation of protein and fat is as a rule all that is necessary to enable one to judge whether or not they are of superior, average or inferior quality.

Many by-products contain as small amounts of crude cellulose as do the grains. Others, such as brans, dried brewers' grains, etc., have from 7 to 12 per cent.

An estimation of the protein and fat only is necessary to enable one to get at their comparative values. Such feeds are bought chiefly for their protein content.

One-fourth to one-third of coarse fodders — hays, straws, corn fodders — consists of crude cellulose. This cellular matter, in so far as it is digestible, is equal in value to the digestible extract matter. Coarse fodders naturally constitute the bulk of the feed for neat stock, and are valuable chiefly for their cellular and extract matter (carbohydrates).

Analyses.

(*a*) *Gluten Feeds.* — The gluten feeds are being sold very largely in Massachusetts markets at the present time. They consist of the skin or hull, the germ and the gluten of the corn kernel. The Pope gluten feeds do not contain the germ.

CONSTITUENTS.	Peoria.	Peoria.	Peoria.	Buffalo.	Pope (White).	Pope (Yellow).
Water (per cent.),	9.00	9.00	9.00	9.00	9.00	9.00
Crude ash (per cent.),	.91	-†	-†	.81	1.22	.99
" cellulose (per cent.),	7.69	-†	-†	7.10	6.04	6.35
" fat (per cent.),	11.72	13.07	11.04	11.92	7.39	7.21
" protein (per cent.),	17.45	21.51	22.00	23.40	25.12	24.60
Extract matter (per cent.),	53.23	-†	-†	47.77	51.23	51.85
	100.00	-	-	100.00	100.00	100.00

† Not determined.

These feeds are kiln dried, and contain from 7 to 10 per cent. of water. For the sake of comparison, they are all calculated to a uniform basis (9 per cent.). It will be noticed that the per cent. of protein varies from 17.5 to 25; *i. e.*, a 30 per cent. variation. The per cent. of fat also varies from 13.07 to 7.21; *i. e.*, a 45 per cent. difference. These feeds, with such wide variations in protein and fat content, are sold practically at the same price per ton.

(*b*) *Oat Feeds.* — This material is being very largely offered. It consists of oat hulls, poor oats and the refuse from oat-meal factories, mixed with more or less ground

barley, bran, inferior corn meal, etc. It is sold under a variety of names, such as oat feed, Quaker oat feed, corn and oat chop, etc.

CONSTITUENTS.	Oat Feed.	Corn and Oat Chop.	Quaker Oat Feed.	Oat Feed.	Oat Feed.
Water (per cent.),	10.00	10.00	10.00	10.00	10.00
Crude ash (per cent.),	4.47	3.60	4.87	-†	3.73
" cellulose (per cent.),	15.13	11.62	14.68	14.88	11.76
" fat (per cent.),	3.64	4.11	3.68	3.73	4.23
" protein (per cent.),	10.70	10.69	12.33	11.32	10.18
Extract matter (per cent.),	56.06	59.98	54.44	-†	60.10
	100.00	100.00	100.00	-	100.00

† Not determined.

We cannot commend this article to farmers. It is made up of different materials, and in putting it upon the market the manufacturer simply is enabled to work off inferior articles and refuse. It of course has considerable feeding value, but the several ingredients can be bought cheaper in other materials, such as corn meal, gluten feed, etc.

(c) *Gluten Meal.* — This feed stuff is prepared from the hard, flinty portion (gluten) of the corn.

Since July the attention of the station has been frequently called to the difference in the appearance of the Chicago gluten meal. It formerly had a golden yellow color. A portion of that now appearing on the market has a light or grayish appearance. The manufacturers claim that this is due to the use of white corn.

CONSTITUENTS.	Chicago.						Pope Gluten Meal.
	OLD PROCESS.	IMPROVED PROCESS.					
	Yellow.	White.	White.	White.	Yellow.	Yellow.	
Water (per cent.),	9.00	9.00	9.00	9.00	9.00	9.00	9.00
Crude ash (per cent.),	.90	1.19	-†	-†	-†	-†	.58
" cellulose (per cent.),	1.10	3.39	-†	-†	-†	-†	1.72
" fat (per cent.),	6.20	6.02	7.20	6.51	6.59	6.93	7.55
" protein (per cent.),	30.50	38.39	38.77	37.41	38.96	42.21	36.60
Extract matter (per cent.),	52.30	42.01	-†	-†	-†	-†	44.55
	100.00	100.00	-	-	-	-	100.00

† Not determined.

The analyses of the so-called improved Chicago meal show it to contain a higher per cent. of protein than the old-process meal contained. The manufacturers claim that this is due to a more complete removal of the starch. Both the white or light and yellow meal have practically the same composition, and are consequently equally valuable for feeding.

(*d*) *Brans and Rice Meal.*

CONSTITUENTS.	Rex Bran.	Cotton-seed Meal Bran.	Cotton-seed Hull Bran.	Rice Meal.
Water (per cent.),	11.00	11.00	11.00	10.00
Crude ash (per cent.),	3.35	2.87	1.93	8.40
" cellulose (per cent.),	18.74	28.60	34.99	5.63
" fat (per cent.),	2.71	3.89	1.09	13.17
" protein (per cent.),	8.90	10.50	2.34	11.59
Extract matter (per cent.),	55.30	43.14	48.65	51.21
	100.00	100.00	100.00	100.00

The above brans are all much inferior to the average wheat bran. The rice meal is a good average sample of its kind, and possesses a feeding value similar to corn meal. Experiments are now in progress with this meal.

(*b*) WATER ANALYSIS.

To determine the healthfulness of a water for drinking, the object is to note the quantity, kind and condition of the organic matter, as well as the total amount of mineral constituents it contains.

All water contains more or less mineral matter in solution, derived from the soil through which it percolates. Moderate quantities (see limit below) are beneficial, and impart to the water a pleasant taste.

The method employed at this laboratory for testing waters is what is known as Wancklyn's process. This chemist interprets the results of his mode as follows: —

1. More than 71 parts per million of chlorine, accompanied by more than .08 part per million of free ammonia and more than .10 part per million of albuminoid ammonia, indicate that the water is polluted with sewage, decaying animal matter, urine, etc. (The amount of chlorine in water depends somewhat on the section of the State from which it comes.)

2. Total solids should not exceed 571 parts per million.

3. Water showing less than 5 degrees as here expressed is termed soft; between 5 and 10 degrees, medium; and above 10 degrees, hard.

"Albuminoid" ammonia is the ammonia derived from the breaking up of vegetable or animal matter in water, as a result of the action of certain chemicals in the process of analysis. Its presence indicates, therefore, that the water contains these matters in solution.

The presence of free or actual ammonia in water shows that these animal or vegetable substances are being decomposed by various bacterial growths. Much free ammonia is an indication that a water is suspicious or even dangerous for drinking.

Chlorine is one of the two components of common salt, and salt is always found both in the urine of human beings

and in that of domestic animals, as well as in many waste waters. Excess of chlorine would therefore make it clear that a water contained sewage of some kind.

It is impossible, from a chemical analysis, to say whether or not a water is contaminated with the specific germ of any contagious disease. This is the work of the bacteriologist.

Character of Waters tested.

We have tested for farmers during the year 124 samples of water. Of these, 81, or 65.3 per cent., were found safe; 18, or 14.5 per cent., rather suspicious; and 25, or 20.2 per cent., dangerous for drinking. Five samples contained very noticeable quantities of lead derived from the lead pipe through which the waters flowed. Soft waters are especially liable to take up the lead. Every one is cautioned against the use of lead pipes, as waters containing this substance are very injurious to the health.

Sample Analyses of Different Waters.

Quality of Water.	Parts per Million.					Clark's Degrees.
	Free Ammonia.	Albuminoid Ammonia.	Chlorine.	Total Solid Matter.	Mineral Solids.	Hardness.
Excellent,	-*	.04	5.00	70.0	46.0	-†
	.02	.07	3.00	70.0	32.0	1.43
	.01	.03	4.00	-†	-†	5.43
Good,	.01	.10	19.00	104.0	54.0	3.25
	.02	.12	7.00	-†	-†	1.11
	.04	.06	8.00	-†	-†	1.26
Suspicious,	.08	.07	18.00	-†	-†	-†
	.04	.11	38.00	336.0	186.0	10.15
	.04	.20	22.00	-†	-†	-†
Dangerous,	.16	.14	35.00	-†	-†	5.71
	.20	.08	22.00	-†	-†	-†
	.26	.48	2.00	84.0	22.0	2.47

* None. † Not determined.

It was not considered necessary to publish the analysis of each water analyzed during the year.

Instructions for sampling and sending Water.

In dipping water from springs or drawing it from open wells, be sure that no foreign material falls into it. Do not take a sample from water that has stood in a pump for any length of time. Send at least two quarts, in *an absolutely clean* vessel. Waters received in dirty vessels are not tested, as the results would be of no value. A clean new stone or earthen jug is to be preferred.

Answer briefly the following questions in regard to the water: —

1. Is it well, shallow spring or hydrant water?
2. Do you suspect it to be the cause of any contagious disease?
3. Do you suspect lead poisoning?
4. What is the character of the ground through which it percolates?
5. How far is the well from house or barn?

(c) DAIRY PRODUCTS.

Milk, Cream, etc.

We have received and tested for farmers during the year 87 samples of milk, 18 samples of cream and 4 samples of butter; 24 samples of butter have also been analyzed for the Dairy Bureau. It is not considered necessary to publish these analyses here. They will be found tabulated at the end of the report.

Information.

Average cow's milk has approximately the following percentage composition: —

	Per Cent.		Per Cent.
Water,	87.0	Albumen,	.50
Fat,	3.7	Milk sugar,	5.10
Casein (curd),	3.0	Ash,	.70

For practical purposes, we generally estimate the percentage of total solids (which includes everything except water) and fat.

For convenience, the Massachusetts milk standard for 1895, as well as the average composition of cream, skim and butter milks, follow: —

CONSTITUENTS.	Massachusetts Standard.	Skim-milk.		Cream.		Buttermilk.
		Deep Setting.	Separator.	Deep Setting.	Separator.	
Total solids (per cent.),	13.00*	9.50	-	26.5	-	8.33
Milk fat (per cent.),	3.70	.32	.10	18.0	25.-35.	.27
Solids not fat (per cent.),	9.30	-	-	-	-	-

* During May and June, 12 per cent.

Instructions for sending Milk.

Milk or cream should be sent by morning express, if possible. It should be marked "Immediate Delivery," and should not be sent later than Thursday of each week. Send one pint of milk and one-half pint of cream, preferably in Lightning or Mason fruit jars. *Be sure the vessels are perfectly clean.* Mix the milk or cream thoroughly before taking the sample, by pouring from one vessel to another.

PART II.

(*a*) CHICAGO GLUTEN MEAL *v.* KING GLUTEN MEAL.

EXPERIMENT WITH COWS.

Object of the Experiment.

The object of the experiment was to compare the relative merits of the two gluten meals for milk production.

Chicago Meal. — The general character and appearance of this meal is well known.

King Meal. — This meal is very probably a by-product from corn, the process of manufacture being somewhat different from that employed in case of the Chicago meal. It contains apparently no husks or germs; the fat from the germ, however, is present, making the meal very rich in this latter substance. For the sake of comparison the composition of the two meals is given below: —

CONSTITUENTS.	Chicago.	King.
Water (per cent.),	9.33	7.34
Crude ash (per cent.),	.13	1.38
" cellulose (per cent.),	1.57	1.30
" fat (per cent.),	4.17	18.48
" protein (per cent.),	33.64	35.57
Extract matter (per cent.),	51.17	35.93

Plan of the Experiment.

Four grade cows were employed, in different stages of lactation. The preliminary feeding period lasted seven days, and the feeding period proper seven days. All other feeds

excepting the two gluten meals remained constant during the experiment. The data will be found in Table I. The following method was employed to overcome the natural milk shrinkage. The cows were divided into two lots. During the first period cows I. and III. received the King meal, at the same time cows IV. and VI. were receiving the Chicago meal; during the second period this order was reversed. This experiment was in operation during June, 1894. The cows were allowed the run of the barn-yard during the day, and so far as possible all conditions were identical during the entire time.

TABLE I.

PERIODS.	Number of Animals.	Length of Feeding Period (Days).	Average Live Weight (Pounds).	Average Daily Rations.								
				TOTAL.				DIGESTIBLE.				
				Wheat Bran (Pounds).	King Gluten Meal (Pounds).	Chicago Gluten Meal (Pounds).	Rowen (Pounds).	Protein (Pounds).	Carbohydrates (Pounds).	Fat (Pounds).	Total (Pounds).	Nutritive Ratio.
King, .	4	10	935	4.5	4.5	–	18	3.30	9.65	1.15	14.1	1:3.8
Chicago, .	4	10	937	4.5	–	4.5	18	3.16	10.49	.56	14.2	1:3.7

TABLE II. — *Average Yield and Cost of Milk.*

PERIODS.	Total Cost of Feeds (Dollars).	Total Yield of Milk (Quarts).	Average Daily Yield per Cow (Quarts).	Cost of Milk per Quart (Cents).
King, ...	$6 61	318.4	11.36	2.08
Chicago, ...	6 61	314.4	11.23	2.10

Comments on the Results.

Table I. shows that the cows consumed the same amount of digestible matter daily in each period.

Table II. shows that the daily yield of milk and the cost per quart were practically identical in each period.

The Chicago meal was in its usual good condition. In spite of the fact that the King meal contained nearly 20 per

cent. of fat, no rancid odor or taste was noticed after the meal had been in the barn six months. Its mechanical condition was all that could be desired. The objection to feeding by-products especially rich in fat is that, if they are fed alone in large quantities (above 3 quarts daily) or fed in combination with other material of a similar nature, the tendency is to cloy the appetite of the animal, or — in warm weather especially — to produce inflammation of the milk glands.

In a daily grain ration of 9 pounds we would not advise feeding over 3 or 4 pounds of but one by-product having above 7 to 8 per cent. of fat.

The principal criticism on this experiment would naturally be the shortness of its feeding periods. This could not have been well avoided. The results obtained, however, are, it is believed, sufficient to give one an idea of the comparative value of the two grains.

(*b*) CHICAGO GLUTEN MEAL *v.* ATLAS MEAL.

Experiment with Cows.

Object of the Experiment.

The experiment was undertaken for the purpose of noting the feeding value of the new by-product Atlas meal, as compared with Chicago gluten meal.

Atlas Meal. — This is a comparatively new article in Massachusetts markets. It consists of the hull, gluten and germ of different grains left behind in the process of alcohol manufacture. It comes into the market ground fairly fine, and contains about the same amount of protein as does the Chicago meal. The amount of cellulose and fat is, however, in excess of the latter. The composition of the two grains follows: —

CONSTITUENTS.	Chicago.	Atlas.
Water (per cent.),	9.00	10.00
Crude ash (per cent.),	.13	.37
" cellulose (per cent.),	1.57	10.75
" fat (per cent.),	4.18	13.75
" protein (per cent.),	33.75	33.57
Extract matter (per cent.),	51.37	31.56

Plan of the Experiment.

The experiment was in operation during January and a part of February, 1895. The cows, four in number, were grades. The feeds consisted of hay, corn and soja-bean ensilage, bran, Chicago gluten meal and Atlas meal. The ensilage, hay and bran remained constant during the entire experiment. The preliminary feeding periods lasted seven days, the two periods proper ten days each. To overcome the natural milk shrinkage the following arrangement was instituted. The cows were divided into two lots. In Period I., cows 3 and 6 were fed Chicago meal at the same time

that cows 4 and 5 were receiving Atlas meal. In Period II. this order was reversed. The cows were kept in the barn during the entire experiment, and were treated precisely alike during both periods. Two composite samples (three days each) of milk were tested during each period. The tables following give the average results from the four cows: —

TABLE I.

PERIODS.	Number of Animals.	Length of Feeding Periods (Days).	Average Live Weight (Pounds).	Average Daily Rations. Total. Wheat Bran (Pounds).	Chicago Meal (Pounds).	Atlas Meal (Pounds).	Corn and Soja-bean Ensilage (Pounds).	Hay (Pounds).	Digestible. Protein (Pounds).	Carbohydrates (Pounds).	Fat (Pounds).	Total (Pounds).	Nutritive Ratio.
Atlas, . .	4	10	943	4	–	4	42.1	5	2.46	9.15	1.17	12.78	1:4.9
Chicago, .	4	10	944	4	4	–	40.6	5	2.62	9.38	.84	12.84	1:4.4

TABLE II. — *Average Yield and Cost of Milk and Butter Fat.*

PERIODS.	Total Cost of Feed (Dollars).	Total Yield of Milk (Quarts).	Average Daily Yield per Cow (Quarts).	Cost per Quart (Cents).	Total Amount of Butter Fat (Pounds).	Total Cost of Butter Fat per Pound (Cents).
Atlas, ...	$7 40	420.7	10.52	1.76	40.57	18.24
Chicago, . .	7 56	423.3	10.58	1.79	40.17	18.82

TABLE III. — *Average Composition of Milk.*

NUMBER OF COW.	PER CENT. SOLIDS. Atlas.	PER CENT. SOLIDS. Chicago.	PER CENT. FAT. Atlas.	PER CENT. FAT. Chicago.
3, ...	14.13	14.33	4.22	4.72
4, ...	13.86	13.65	4.88	4.60
5, ...	13.38	13.16	4.17	4.12
6, ...	14.33	13.71	4.52	4.06
Average, ...	13.93	13.71	4.45	4.38

Results.

The cost and quantity of milk and butter fat are so nearly equal in each case as to be considered practically identical. If the quality of the Atlas meal is maintained, it can be regarded as an excellent food for milch cows and neat stock in general.

(c) WHAT CONSTITUTES A "SPACE" OF CREAM.

J. B. LINDSEY AND GEO. A. BILLINGS.

In the report of the State Experiment Station for 1894 it was shown that the butter fat in the cream gathered from 165 different farmers varied from 11 to 22 per cent. Such figures only serve to emphasize the unreliability of the "space" as a basis for payment.

During the past autumn we have tested the cream raised by the deep-setting process from each of the six cows belonging to the station. The conditions were precisely alike in each case, the milk being immersed for the same length of time, and the temperature of the water maintained at 38 to 40 degrees. The cows were all fresh in milk, having calved from one to two months previously.

History of the Cows.

Cow I., grade Ayrshire, six years old, weighing 800 pounds, yielding about 4 per cent. fat in milk.

Cow II., native, nine years old, weighing 900 pounds, yielding 4 per cent. fat in milk.

Cow III., grade Ayrshire-Jersey, seven years old, weighing 850 pounds, yielding 4.2 per cent. fat in milk.

Cow IV., grade Jersey, six years old, weighing 1,050 pounds, yielding 5 per cent. fat in milk.

Cow V., grade Durham, seven years old, weighing 1,050 pounds, yielding 3 per cent. fat in milk.

Cow VI., grade Durham-Jersey, about seven years old, weighing 1,000 pounds, yielding 5 per cent. fat in milk.

Table I. shows the daily results and the average for the three days (two days in case of cows V. and VI.).

TABLE I.

NUMBER OF COW.	Number of Days.	Milk per Day (Pounds).	Spaces Cream per Day.	Per Cent. of Fat in Cream.	Per Cent. of Fat in Skim-milk.
I., . . .	1, ...	25.90	8.10	16.90	.20
	1, ...	26.00	7.50	16.60	.15
	1, ...	25.50	7.80	16.10	.17
	Average, .	25.80	7.80	16.53	.17
II., . . .	1, ...	21.50	5.30	16.15	.55
	1, ...	22.00	5.50	15.90	.57
	1, ...	22.75	5.90	17.30	.55
	Average, .	22.08	5.57	16.45	.56
III., . . .	1, ...	25.50	11.50	11.20	.25
	1, ...	26.87	10.80	12.05	.30
	1, ...	26.50	11.60	12.70	.25
	Average, .	26.30	11.30	11.98	.27
IV., . . .	1, ...	25.95	8.10	21.00	.18
	1, ...	27.12	8.40	21.45	.20
	1, ...	25.00	8.10	22.65	.13
	Average, .	26.02	8.20	21.70	.17
V., . . .	1, ...	28.00	7.00	15.70	.17
	1, ...	30.63	7.10	16.20	.15
	Average, .	29.31	7.05	15.95	.16
VI., . . .	1, ...	31.12	10.90	20.25	.15
	1, ...	31.50	8.80	19.45	.13
	Average, .	31.31	9.85	19.85	.13

TABLE II. — *Showing the Results on the Basis of 25 Pounds of Milk per Cow.*

NUMBER OF COW.	Spaces of Cream.	Per Cent. of Fat in Cream.	NUMBER OF COW.	Spaces of Cream.	Per Cent. of Fat in Cream.
I., ...	7.56	16.53	IV., . . .	7.89	21.70
II., ...	6.30	16.45	V., . . .	6.01	15.95
III., ...	10.74	11.98	VI., . . .	7.87	19.85

Cows I., II. and V. produced the smallest number of spaces of cream, containing 16 to 16½ per cent. of fat. Cow III. produced nearly 11 spaces of cream with 12 per cent. of fat. Cows IV. and VI. produced nearly 8 spaces of cream each, containing from 20 to nearly 22 per cent. of fat.

According to the present system, cream is paid for at the same price per space, whether it contains 12, 16 or 22 per cent. of butter fat, *i. e.*, whether equal quantities of such cream will produce 12, 16 or 22 pounds of butter. Under this system a farmer with a herd of extra butter-producing cows, yielding cream by the deep-setting process, containing 19 to 22 per cent. of fat, receives no more money than another farmer who produces a like quantity of cream testing but 15 or 16 per cent. of fat. *The injustice must be apparent* to every thinking farmer. The investigation, as shown in the above tables, might have been carried still further by weighing the cream, calculating the *amount* of butter fat produced, and seeing how much butter a given number of spaces of each cow's cream would produce. This was done, however, in last year's investigation, and, at the risk of repetition, the summary of the results bearing on this point is presented in Table III. Our object in the present experiment has been simply to show how the per cent. of fat in the cream of six individual cows varied under exactly similar conditions.

Table III. — *Summary of Results obtained in 1894 with Cream gathered from 165 Farmers, showing Butter Equivalent from 100 Spaces of Graded Cream, and Value of Same.*

Pounds of Butter Fat from 100 Spaces of Cream.	Number of Patrons.	Per Cent. of Patrons.	Equivalent to Butter (Pounds).	Value of Butter at 25 Cents per Pound.
8-12, ...	10	6.1	13.42*	$3 35
12-13, ...	23	14.0	14.58	3 64
13-14, ...	52	31.5	15.75	3 94
14-15, ...	41	24.9	16.92	4 23
15-16, ...	30	18.2	18.08	4 52
16-18, ...	9	5.5	19.83	4 96

* Figured on the basis of 11.5 pounds of butter fat.

A full explanation of the Babcock system (by which the farmer is paid for the number of pounds of butter fat actually furnished by him), and how to put it into practical operation, has already been published.* This system offers encouragement for every one to improve his herd by weeding out the unprofitable cows and putting in their places only those that will produce good yields of rich milk.

Under the space system those farmers having extra cows that are well taken care of simply help out their shiftless neighbors who keep inferior animals. That the latter class of farmers is glad to be thus aided, and is as a rule opposed to any change, is not to be wondered at. How long the more thrifty, painstaking farmers will be willing to continue this, is a question for them to decide.

* "Creamery Practice," by J. B. Lindsey, published by Dairy Bureau, 20 Devonshire Street, Boston, Mass.

(*d*) WHEAT MEAL *v.* RYE MEAL FOR PIGS.

Object of the Experiment.

In this experiment it was intended to compare the feeding values of wheat and rye meal, when fed in combination with skim-milk to growing pigs.

Plan of the Experiment.

The pigs were divided into two lots, two barrows and a sow being in each lot. The experiment was divided into three periods, covering in all 106 days. It was intended, in the first period, to feed 3 ounces of meal to each quart of milk, but the supply of milk being limited, some Peoria gluten feed was added to keep the ratio of protein to carbohydrates as 1 to 3.5.

In the second period 4 quarts of milk were fed daily, together with sufficient wheat or rye meal to satisfy appetites.

In the third period 4 quarts of milk were fed daily, in connection with equal parts of wheat or rye meal and corn meal to satisfy the appetites of the animals. Sufficient water was added to the milk and meal to furnish the necessary amount of liquid. The pigs were fed three times daily.

Table I. — *Feeding Plan.*

PERIOD.	Number of Days.	Feed.	Nutritive Ratio.
I., . .	58	3 ounces wheat or rye meal to each quart of milk, . .	1:3.6
II., . .	13	4 quarts milk daily, and wheat or rye meal to satisfy appetites.	1:4.0
III., . .	35	4 quarts milk, and equal parts wheat or rye meal and corn meal to satisfy appetites.	1:5.3

Table II. — *Average Daily Gain* (*Pounds*).

LOT.	Period I.	Period II.	Period III.	Total Average Daily Gain.
I., wheat, ...	1.06	1.21	1.49	1.22
II., rye, ...	1.00	1.15	1.20	1.10

TABLE III. — *Total Feed consumed.*

LOT I. (WHEAT).

PERIODS.	Skim-milk (Quarts).	Wheat Meal (Pounds).	Peoria Feed (Pounds).	Corn Meal (Pounds).	Nutritive Ratio.
I.,	744.0	205.1	73.5	-	1:3.6
II.,	195.0	114.0	-	-	1:4.0
III.,	450.0	212.5	-	212.5	1:5.2
Total,	1,389.0	531.6	73.5	212.5	-
Equal to dry matter,	283.7*	468.0	68.3	180.6	-

* Pounds.

LOT II. (RYE).

PERIODS.	Skim-milk (Quarts).	Rye Meal (Pounds).	Peoria Feed (Pounds).	Corn Meal (Pounds).	Nutritive Ratio.
I.,	744.0	205.10	73.5	-	1:3.8
II.,	195.0	114.00	-	-	1:4.4
III.,	450.0	183.75	-	183.75	1:5.4
Total,	1,389.0	502.80	73.5	183.75	-
Equal to dry matter,	283.7*	432.40	68.3	156.20	-

* Pounds.

TABLE IV.

	Lot I.	Lot II.
Average live weight at beginning of experiment (pounds),	33.33	34.20
Average live weight at end of experiment (pounds),	162.70	150.00
Average gain of each pig (pounds),	129.37	115.80
Average daily gain (pounds),	1.22	1.10
Dry matter required to produce 1 pound live weight (pounds),	2.58	2.71
Skim-milk actually returned per quart (fraction of cent),	.65	.55
Cost of feed for each pound of live weight gained (cents),*	4.25	4.58
Price received per pound of live weight (cents),	4.80	4.80

* On basis of following prices for feed: skim-milk, 2 cents per gallon; wheat and rye, $24 per ton; Peoria gluten feed, $21 per ton; and corn meal, $23 per ton.

Comments on Results.

Both lots of pigs made very fair gains, and the results as a whole compare favorably with other experiments, when skim-milk was fed with other grains. The average daily gain was nearly $1\frac{1}{4}$ pounds, and the dry matter required to make 1 pound of live weight averaged 2.65 pounds. The skim-milk returned .6 of one cent per quart, and the live weight cost 4.37 cents per pound, allowing skim-milk to be worth one-half cent per quart, and the grains as noted. The wheat meal seemed to give rather better results, especially in the last period. During this latter period the pigs fed on the rye-meal ration were off feed a good deal of the time, and gained less in weight. If the experiment had been continued longer, the results would have been still more in favor of the wheat meal.

Suggestions for Feeding Wheat or Rye Meal.

With pigs weighing from 30 to 100 pounds, feed 3 to 6 ounces meal to each quart of milk; with pigs weighing from 100 to 175 pounds, feed skim-milk at disposal (4 to 6 quarts per pig), and equal parts of wheat or rye meal and corn meal to satisfy appetites.

(*e*) SALT HAYS AND MEADOW OR SWALE HAY.

A. — Digestibility.
B. — How to feed them.

Summary of Results.

(*a*) Black grass, high-grown salt hay, branch grass and low meadow fox grass are all valuable fodder articles. In the present experiment black grass contained more protein and showed a higher average digestibility, and is therefore superior to the other three hays. There is no wide difference, however. Timothy hay shows more total digestible organic matter, but is noticeably inferior to three of the salt hays in digestible protein. Black grass might be classed as but little inferior to average timothy hay. High-grown salt hay, branch grass and fox grass resemble each other very closely in feeding value.

(*b*) Salt hays at average market prices are decidedly cheaper to feed than English hay.

(*c*) Meadow or swale hay is a very inferior article. It contained 150 to 200 pounds less digestible matter than did the salt hays, and but 39 per cent. of digestible dry matter.

(*d*) Hays containing much less than 50 per cent. of digestible dry matter should be regarded as of very inferior quality.

A. — Digestibility.

At the request of the experiment station, farmers in the vicinity of Newburyport sent four samples of salt hay. It was the intention of the writer to analyze these hays and test their comparative digestibilities. The hays were named as follows : —

1. Black grass (fine, and of dark color; consisted almost exclusively of *Juncus bulbosus*).
2. High-grown salt hay.
3. Branch grass.
4. Low meadow fox grass.

The low meadow fox grass appeared to consist practically of what is also called rush salt grass (*Spartina juncea*), and both the high-grown salt hay and the branch grass were composed of this as a basis, mixed with more or less coarse grass, probably *Spartina stricta*, variety *glabra*. The branch grass contained rather more of the coarse material than did the high-grown salt hay.

A sample of meadow or swale hay was also obtained, through the kindness of Mr. Chas. J. Peabody of Topsfield, in which vicinity large quantities are cut yearly. This hay grows in the fresh-water meadows, and is composed of fresh-water grasses, sedges, brakes and wild flowers.

The digestion tests were made with sheep, because these animals are much easier to work with, and give at the same time similar results as do cows and steers.

How the Digestible Matter of a Feed is determined.

First ascertain the amount and composition of the feed consumed by an animal in a given length of time, also the amount and composition of the fæces or undigested portion excreted in the same time on the basis of dry matter. The difference between them will represent the amount of the various constituents of the food digested.

The percentages of the constituents digested are called the digestion coefficients.

Table I. — *Composition of Hays.*

[The analysis of each hay is given on the basis of 15 per cent. of water, for the sake of comparison.]

FODDER CONSTITUENTS.	Black Grass.	High-grown Salt Hay.	Branch Grass.	Low Meadow Fox Grass.	Meadow Hay.	Timothy Hay for Comparison.
Water,	15.00	15.00	15.00	15.00	15.00	15.00
Crude ash,	9.91	6.92	8.75	4.96	5.27	4.30
" cellulose,	22.78	22.45	22.50	22.58	26.40	28.40
" fat,	2.23	2.13	1.88	2.18	1.59	2.40
" protein,	8.08	6.36	7.03	6.06	6.77	6.30
Nitrogen-free extract matter,	42.00	47.14	44.84	49.22	44.97	43.60
	100.00	100.00	100.00	100.00	100.00	100.00

TABLE II. — *Showing Average Digestion Coefficients obtained with Two Sheep.*

FODDER CONSTITUENTS.	Black Grass.	High-grown Salt Hay.	Branch Grass.	Fox Grass.	Meadow Hay.	Timothy Hay for Comparison.
Total dry substance,	59.5	53.0	56.0	53.0	39.0	58.0
Crude cellulose,	60.5	50.0	52.0	51.0	33.0	53.0
" fat,	41.5	47.0	32.0	24.0	44.0	61.0
" protein,	63.0	63.0	62.5	57.0	34.0	48.0
Nitrogen-free extract matter,	57.0	53.0	54.0	52.0	46.0	63.0

TABLE III. — *Showing Pounds of Digestible Organic Matter in 2,000 Pounds of the Several Hays, assuming Each Hay to contain an Average Amount of Water (15 Per Cent.).*

FODDER CONSTITUENTS.	Black Grass.	High-grown Salt Hay.	Branch Grass.	Fox Grass.	Meadow Hay.	Timothy Hay for Comparison.
Crude cellulose,	275.6	224.4	234.0	230.2	174.24	301.00
" fat,	18.5	20.0	12.0	10.4	14.03	29.28
" protein,	101.8	80.0	87.8	69.0	46.02	60.40
Extract matter,	479.8	499.6	484.2	511.8	413.72	549.36
Total,	875.7	824.0	818.0	821.4	648.06	940.04

The teachings of the above tables will be found summarized at the beginning of the article. The writer has hesitated about making too sharp distinctions between the several kinds of salt hay, in view of the fact that he has worked with but one sample of each kind. It is well known that late-cut hays are inferior in per cent. of protein and less digestible than early-cut hays; and the writer has no means of knowing with certainty, either from the appearance of the samples or otherwise, whether or not they were cut at the same stage of growth. Very few blossoms were to be found indicative of an early cutting. It is also recognized that the condition and situation of the land exert an influence upon the quality of the hay. On the other hand, the hays were selected by men practically familiar with such material, and pronounced fair samples of their kind.

B. — How to feed Salt and Meadow Hays.

(*a*) *Salt Hays.*

Only general directions can be given. First, these hays, having a value approaching an average English hay, can be fed in place of the latter article in so far as composition and digestibility (*i. e.*, quality) are concerned. In the second place, however, the amount of salt they contain will exert a controlling influence on the quantity that the animal can consume. The per cent. of salt in the four samples received was as follows: —

	Black Grass.	High-grown Salt Hay.	Branch Grass.	Fox Grass.	Average English Hay.
Per cent. salt,	6.35	3.20	4.09	2.51	1.50

This per cent. would probably vary from time to time, depending on the frequency with which the salt water came in contact with the meadows, etc. Should black and branch grasses contain on an average as much salt as found in the present case, it would hardly seem wise to feed over one-third to one-half of these grasses in the entire coarse fodder ration, while in case of the high-grown salt hay and the fox grass two-thirds to even the entire coarse fodder ration could consist of these hays. The experience of practical feeders can and has undoubtedly solved this problem. The majority of farmers will probably prefer to feed about one-half salt hay and one-half English hay or other coarse material.

Coarse fodders can for practical purposes be fed *ad libitum; i. e.*, the animals can be given all they will consume. This can be left to the judgment of the practical feeder.

Grain Rations (on basis of milch cows of 1,000 pounds live weight). — The following rations are combined to go with the coarse fodders: —

I.		II.	
	Pounds.		Pounds.
Cotton-seed meal,*	100	Linseed meal,*	100
Wheat bran, ...	100	Pope or King gluten meal,* .	100
Corn meal,†.	100	Wheat bran, ...	200
Mix and feed 6 to 9 quarts daily.		Feed 7 to 9 quarts daily.	

III.		IV.	
	Pounds.		Pounds.
Chicago gluten meal,* . .	100	Gluten meal, ...	100
Wheat bran, ...	100	Corn meal, ...	100
Gluten feed,‡	100	Feed 6 quarts daily.	
Feed 6 to 9 quarts daily.			

V.	
	Pounds.
Cotton-seed meal, ...	100
Wheat bran, ...	100
Feed 8 quarts daily.	

* Cotton-seed meal, linseed meals and the various gluten meals can be substituted one for the other. Cotton-seed meal, King and Pope gluten meal, on account of the high percentage of fat they contain, should not be fed together in the same ration.

† Chicago maize feed, Buffalo and Peoria or other gluten feeds can be used interchangeably.

‡ Gluten feeds can usually be substituted for corn meal with good effect.

(*b*) *Meadow Hays* (*for Milch Cows of 1,000 Pounds Live Weight*).

Meadow hay, being of inferior nutritive value, must be supplemented with feed stuffs containing large amounts of digestible matter, — especially protein, — in order to secure good results.

Coarse Fodder Ration 1. — Feed all the meadow hay the animal will eat.

Grain Rations for above.

I.		II.	
	Pounds.		Pounds.
Corn meal, ...	200	Corn meal, ...	100
Cotton-seed meal, . . .	100	Wheat bran, ...	100
Feed 9 quarts daily.		Cotton-seed meal, . . .	100
		Feed 10 quarts daily.	

III.

	Pounds.
Wheat bran,	100
Gluten feed,	100
Feed 14 to 16 quarts daily.	

Coarse Fodder Ration 2. — About one-half English hay and one-half meadow hay, or about one-half corn ensilage (30 pounds) and all the meadow hay the animal will eat.

Grain Rations for Above.

I.	Pounds.	II.	Pounds.
Corn meal,	150	Wheat bran,	100
Cotton-seed meal,	100	Gluten feed,	100
Feed 7 quarts daily.		Feed 10 to 12 quarts daily.	

Remarks. — The writer questions the wisdom of a system of farming in which much labor is devoted to securing meadow hay for feeding to farm animals. The large amount of grain necessary to be fed in order to secure reasonably nutritive rations calls for a considerable outlay of money, which renders the various rations of doubtful economy.

The tendency of modern dairy farming is to raise crops containing more nitrogenous matter (protein), and thus reduce the amount of grain to be purchased.

To farmers who have been gathering and feeding large quantities of meadow hay the writer would make the following suggestions: —

In addition to English hay, raise annual crops, such as peas and oats, vetch and oats and Hungarian grass. Cut these for hay. Grow corn fodder and soja-bean fodder, and put into a silo in the proportion of two parts corn to one part soja beans. Such a system will give large amounts of nutritious winter feed, and will enable one to get along with one-half of the grain feed mentioned above.

How to purchase Grains.

In making up grain rations cost must be considered, and one should be familiar with the fluctuating market values of the several feed stuffs in order to make economical combinations. The following figures show the approximate commercial values of the different feeds, based on the amount of digestible protein they contain : —

Wheat bran,	$18 00	$14 00
Corn meal,	19 00	15 00
Wheat middlings,	21 00	16 00
Brewers' grains,	21 00	16 00
Malt sprouts,	23 00	18 00
Gluten and maize feeds,	28 00	22 00
Atlas meal,	31 00	24 00
Old-process linseed meal,	31 00	24 00
New-process linseed meal,	32 50	25 00
Gluten meals,	35 00	27 00
Cotton-seed meal,	35 00	27 00

The above figures do not express the relative physiological effect of the different grains, but show their comparative values in digestible protein after figuring the digestible carbohydrates and fat at a definite price. They can be used as guides in purchasing.

Compilation of Analyses of Fodder Articles and Dairy Products,

made at

AMHERST, MASS.

1868-1896.

Prepared by C. S. Crocker.

A. Fodder Articles.

B. Fertilizing Ingredients in Fodders.

C. Dairy Products.

A. Composition and Digestibility of Cattle Feeds.

[Figures equal percentages or pounds in 100.]

NAME.	Analyses.	Composition.										Digestibility.							
		Fresh or Air-dry Substance.						Water-free Substance.				Fresh or Air-dry Substance.				Water-free Substance.			
		Water.	Ash.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.
I. Green Fodders.																			
Fodder corn,	33	74.90	1.21	5.2	.5	2.0	11.7	25.2	2.4	9.8	56.7	2.7	.40	1.1	8.7	25.2	1.8	5.2	42.0
Fodder-corn ensilage,	38	78.30	1.20	6.0	.8	1.9	11.8	27.7	3.8	8.7	54.4	4.1	.60	.9	7.9	18.8	3.0	4.5	36.4
Corn and soja-bean ensilage,	3	76.50	2.60	7.3	.9	2.5	10.2	31.2	4.0	10.5	43.5	-	-	-	-	-	-	-	-
Oat and pea ensilage,	1	38.02	5.70	19.4	2.4	8.5	26.0	31.3	3.9	13.7	41.8	-	-	-	-	-	-	-	-
Millet and soja-bean ensilage,	6	75.70	3.00	7.3	1.0	3.0	10.0	30.2	4.0	12.3	41.4	-	-	-	-	-	-	-	-
Millet ensilage,	3	73.80	2.40	7.5	.8	1.7	13.8	33.3	3.1	6.6	52.3	-	-	-	-	-	-	-	-
Sorghum,	6	82.60	1.20	4.6	.3	1.5	9.8	26.7	1.5	8.7	56.3	2.7	.20	.7	7.2	15.8	1.1	4.0	41.7
Common millet,	9	64.60	1.70	11.0	1.0	2.6	19.1	31.0	2.7	7.5	54.0	-	-	-	-	-	-	-	-
Japanese millet (white head),	3	75.20	1.20	8.5	.6	2.2	12.3	34.5	2.3	8.7	49.6	-	-	-	-	-	-	-	-
Japanese millet (red head),	6	72.70	1.70	8.8	.5	1.9	14.4	32.1	2.0	6.9	52.9	-	-	-	-	-	-	-	-
Panicum miliaceum,	1	69.40	1.70	8.2	1.2	1.8	17.7	26.8	3.8	6.0	57.8	-	-	-	-	-	-	-	-
Panicum crus-galli,	2	72.90	2.10	7.6	.7	2.7	14.0	27.9	2.5	9.7	52.2	-	-	-	-	-	-	-	-
Mochi millet,	3	62.60	2.60	9.5	.7	3.7	20.9	25.6	1.8	9.9	55.7	-	-	-	-	-	-	-	-

Green oats,	6	74.00	2.10	7.8	.8	3.6	11.7	30.0	2.9	13.9	44.9	4.4	.50	2.5	8.5	17.0	1.7	9.7	32.8
Green barley,	1	79.10	1.80	7.9	.6	2.7	7.9	37.8	2.9	13.1	37.5	4.4	.40	1.8	5.8	21.1	1.7	9.2	27.4
Green rye,	2	72.00	1.60	8.9	.6	2.1	14.8	31.8	2.2	7.5	52.8	5.0	.40	1.5	10.8	19.1	1.3	4.2	38.5
Timothy (*Phleum pratense*),	2	65.40	1.70	11.3	.7	3.2	17.7	32.9	2.0	8.5	51.3	6.3	.40	1.5	11.7	18.4	1.1	4.1	33.9
Hungarian grass,	2	74.20	2.10	7.0	.5	2.6	13.6	27.9	1.7	9.4	53.0	4.8	.30	1.6	.9	19.0	.9	5.8	35.0
Vetch and oats (1 part vetch, 4 parts oats),	1	79.20	1.90	6.3	.8	2.8	9.0	30.3	3.9	13.3	43.7	4.2	.20	1.7	4.9	20.0	.7	8.0	23.6
Vetch and oats (1 part vetch, 9 parts oats),	3	81.00	1.70	6.4	.5	1.9	8.5	33.6	2.5	10.1	44.8	-	-	-	-	-	-	-	-
Vetch and oats (equal parts of each),	1	82.00	1.70	5.4	.5	3.0	7.4	29.8	2.8	16.8	41.3	-	-	-	-	-	-	-	-
Barley and peas,	1	83.90	1.30	5.4	.5	2.2	6.7	33.5	3.0	13.4	41.8	3.2	.24	1.7	4.1	20.1	1.3	10.3	25.5
Oats and peas,	2	84.00	1.30	4.7	.5	2.4	7.1	29.4	2.8	15.1	44.4	2.8	.24	1.8	4.3	17.6	1.2	11.6	27.1
Horse bean,	1	84.80	.90	4.3	.4	2.5	7.1	28.2	2.3	16.7	47.0	-	-	-	-	-	-	-	-
Flat pea,	2	78.80	1.90	5.2	.9	6.1	7.1	24.3	4.1	29.0	33.5	-	-	-	-	-	-	-	-
Soja bean,	14	75.50	2.50	6.5	1.1	4.2	10.2	26.5	4.6	17.3	41.6	3.4	.30	2.9	6.7	14.0	1.4	11.9	27.5
Soja bean (early white),	4	69.80	3.90	6.7	.8	5.0	13.8	22.8	2.7	16.5	45.2	-	-	-	-	-	-	-	-
Soja bean (early green),	1	69.90	3.90	7.1	1.2	5.8	12.1	23.5	3.9	19.4	40.2	-	-	-	-	-	-	-	-
Soja bean (early black),	1	82.20	2.30	4.5	.6	2.9	7.5	25.1	3.4	16.2	42.4	-	-	-	-	-	-	-	-
Soja bean (medium black),	1	76.90	2.90	5.0	1.6	5.0	8.6	21.7	6.8	21.7	37.1	-	-	-	-	-	-	-	-
Soja bean (late),	4	74.00	3.50	5.5	.7	5.9	10.4	21.1	2.8	22.8	39.7	-	-	-	-	-	-	-	-
Bokhara clover,	3	78.80	2.10	6.3	.6	4.2	8.0	29.5	3.0	19.7	37.9	-	-	-	-	-	-	-	-
Kidney vetch,	1	80.80	2.60	2.9	.7	3.5	9.5	14.9	3.5	18.4	49.9	-	-	-	-	-	-	-	-
Serradella,	3	82.40	1.90	5.3	.4	2.6	7.4	30.1	2.4	15.0	41.5	2.7	.30	2.0	19.0	15.1	1.6	11.3	26.1
Prickly comfrey,	1	86.80	2.80	1.5	.3	2.3	6.3	11.0	2.1	17.5	48.3	-	-	-	-	-	-	-	-

A. *Composition and Digestibility of Cattle Feeds* — Continued.

NAME.	Analyses.	COMPOSITION.										DIGESTIBILITY.							
		FRESH OR AIR-DRY SUBSTANCE.						WATER-FREE SUBSTANCE.				FRESH OR AIR-DRY SUBSTANCE.				WATER-FREE SUBSTANCE.			
		Water.	Ash.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.
I. Green Fodders — Concluded.																			
Spurry,	1	72.30	2.60	7.0	.1	2.9	14.1	25.4	3.9	10.3	51.1	-	-	-	-	-	-	-	-
White lupine,	1	85.30	.70	4.6	.4	2.7	6.3	31.2	2.4	18.7	42.7	-	-	-	-	-	-	-	-
Yellow lupine,	1	86.00	1.50	3.8	.3	2.5	5.9	27.1	1.9	17.8	42.1	-	-	-	-	-	-	-	-
Spanish moss,	1	60.80	1.10	12.7	1.0	1.8	22.6	32.6	2.5	4.5	57.7	-	-	-	-	-	-	-	-
II. Hay and Dry Coarse Fodders.																			
English hay (mixed grasses),	60	14.00	5.40	26.7	2.4	8.1	43.1	31.1	2.8	9.5	50.3	16.0	1.1	4.8	25.4	18.7	1.4	5.6	29.7
Canada hay,	4	14.00	4.60	28.1	2.1	6.1	44.9	32.7	2.5	7.1	52.2	14.6	1.2	2.9	32.9	19.0	1.7	3.9	32.9
Rowen of mixed hays,	15	17.00	5.90	22.2	3.0	10.5	41.2	26.8	3.6	12.7	49.7	14.2	1.1	7.1	27.2	17.2	1.2	7.9	32.8
Timothy hay,	6	14.00	4.20	28.3	1.9	8.5	44.1	32.9	2.2	8.7	51.3	14.7	1.1	4.1	27.8	19.1	1.3	4.9	32.3
Red-top hay (*Agrostis vulgaris* With.),	4	14.00	4.30	28.3	1.4	6.8	45.2	32.9	1.6	7.9	52.6	17.3	.7	4.1	28.0	20.1	.8	4.8	32.6
Kentucky blue-grass (*Poa pratensis* L.),	2	14.00	7.20	29.7	1.8	7.5	39.7	34.6	2.1	8.7	46.2	-	-	-	-	-	-	-	-
Orchard grass (*Dactylis glomerata* L.),	4	14.00	6.10	30.0	2.5	8.1	39.3	34.9	2.9	9.4	45.7	18.3	1.4	4.9	21.6	21.3	1.6	5.6	25.1
Meadow fescue (*Festuca pratensis* Huds.),	5	14.00	7.90	31.7	1.6	5.8	39.8	36.9	1.9	6.8	46.3	-	-	-	-	-	-	-	-

Perennial rye-grass (*Lolium perenne* L.),	4	14.00	7.90	25.4	2.1	10.1	41.4	29.6	2.4	11.7	48.2	-	-	-	-	-	-	-	-
Italian rye-grass (*Lolium Italicum* A. Br.),	4	14.00	6.50	28.6	1.6	7.1	42.2	33.3	1.9	8.2	49.1	-	-	-	-	-	-	-	-
Hungarian grass,	1	14.00	4.90	27.5	1.9	8.2	43.5	32.0	2.2	9.5	50.6	18.7	1.2	4.9	29.1	21.8	1.4	5.7	33.9
Barn-yard grass,	1	14.00	8.60	29.0	1.7	13.1	32.9	33.7	2.0	15.3	38.2	18.2	1.0	8.1	21.7	21.2	1.2	9.5	25.2
Hay of black grass (salt),	2	16.00	7.70	24.4	2.4	6.8	41.6	29.1	2.9	8.1	49.5	14.6	1.0	4.3	23.3	17.5	1.2	5.1	27.7
High-grown salt hay,	1	16.00	7.00	22.2	2.1	6.3	46.6	26.4	2.5	7.5	55.5	11.0	1.0	4.0	24.7	13.2	1.2	4.7	29.4
Branch grass (salt),	1	16.00	8.80	22.3	1.8	7.0	44.4	26.5	2.2	8.3	52.8	11.5	.6	4.3	24.0	13.8	.7	5.1	28.5
Low meadow fox grass (salt),	1	16.00	5.40	22.3	2.2	6.0	48.6	26.6	2.6	7.1	57.9	11.4	.5	3.4	25.3	13.7	.6	4.0	30.1
Salt hay (variety unknown),	2	16.00	4.30	24.0	2.5	3.4	50.5	27.8	3.0	4.1	60.1	-	-	-	-	-	-	-	-
Vetch and oats (1 part vetch, 4 parts oats),	1	14.00	7.60	26.1	3.3	11.4	37.6	30.3	3.9	13.3	43.7	17.2	.6	6.8	20.3	20.0	.7	8.0	23.6
Vetch and barley,	2	14.00	5.30	27.9	2.0	11.9	38.9	32.4	2.3	13.9	45.2	18.4	.4	7.1	21.0	21.4	.5	8.3	24.4
Low meadow or swamp hay,	2	14.00	5.80	26.7	1.9	7.1	44.8	31.1	2.2	8.3	52.1	8.8	.8	2.4	20.6	10.2	1.0	2.8	23.9
Millet,	6	16.00	4.30	28.0	1.8	6.5	43.4	33.3	2.1	7.8	51.7	-	-	-	-	-	-	-	-
Oats in bloom,	1	15.00	5.60	30.6	2.4	5.5	42.0	34.1	2.9	6.6	50.0	17.1	1.5	3.9	30.7	19.0	1.8	4.6	36.5
Oats in milk,	1	15.00	5.20	29.2	2.3	9.3	39.1	34.3	2.7	10.9	46.0	16.3	1.4	6.5	28.5	19.2	1.7	7.6	32.6
Oats, ripe,	1	15.00	5.30	30.9	2.2	5.2	41.6	36.3	2.6	6.1	48.9	-	-	-	-	-	-	-	-
Winter rye in bloom,	1	15.00	5.40	28.1	2.2	9.1	40.2	33.0	2.6	10.7	47.3	15.7	1.4	6.4	29.4	18.4	1.6	7.5	34.5
Barley in milk,	1	15.00	4.20	24.7	2.4	8.8	44.9	29.1	2.8	10.3	52.8	13.8	1.5	6.2	32.8	16.3	1.7	7.2	38.5
Dry corn fodder,	4	20.00	4.10	23.4	1.4	6.2	45.9	29.3	1.8	7.7	56.1	15.2	1.0	3.7	34.0	16.1	1.4	4.1	42.6
Corn stover,	30	20.00	4.70	28.3	1.1	5.9	40.4	34.9	1.4	7.4	50.5	18.9	.6	3.1	25.9	23.4	.7	3.8	32.3
Common buckwheat,	1	8.50	13.40	17.8	2.7	16.4	41.2	19.4	3.0	17.9	45.1	-	-	-	-	-	-	-	-
Silver-hull buckwheat,	1	8.90	9.30	24.7	2.4	11.1	43.6	27.1	2.6	12.2	47.9	-	-	-	-	-	-	-	-

A. Composition and Digestibility of Cattle Feeds — Continued.

NAME.	Analyses.	Composition.										Digestibility.							
		Fresh or Air-dry Substance.						Water-free Substance.				Fresh or Air-dry Substance.				Water-free Substance.			
		Water.	Ash.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.
II. Hay and Dry Coarse Fodders — Con.																			
Japanese buckwheat,	1	5.70	11.70	33.9	2.1	10.2	36.4	36.0	2.2	10.8	38.6	-	-	-	-	-	-	-	-
Teosinte,	1	6.10	6.60	27.1	1.2	9.1	49.9	28.9	1.3	9.7	53.1	-	-	-	-	-	-	-	-
Mammoth red clover,	3	11.40	8.70	24.4	1.9	14.0	39.6	27.5	2.1	15.8	44.8	-	-	-	-	-	-	-	-
Alsike clover,	6	10.00	10.70	23.6	2.3	14.9	38.5	26.2	2.6	16.6	42.7	12.5	1.2	9.2	27.2	13.9	1.3	9.8	30.3
Medium red clover,	2	5.60	8.50	28.7	2.4	14.0	40.8	30.4	2.5	14.8	43.3	15.2	1.2	9.2	30.0	16.1	1.3	9.8	30.7
Ground clover (poultry feed),	1	14.80	7.40	28.3	2.0	12.6	34.9	33.2	2.3	14.8	41.0	-	-	-	-	-	-	-	-
Lucerne (alfalfa),	6	9.70	7.20	27.7	1.7	12.3	41.4	30.7	1.9	13.6	45.8	13.6	1.0	9.5	22.3	15.0	1.2	10.5	26.4
Sand lucerne,	1	8.80	8.80	19.4	2.4	14.9	45.7	21.3	2.6	16.3	50.2	-	-	-	-	-	-	-	-
Bokhara clover,	5	8.00	8.30	27.5	2.9	15.8	37.5	29.9	3.2	17.2	40.7	-	-	-	-	-	-	-	-
Blue melilot,	1	8.20	13.70	25.0	1.6	12.7	39.8	27.2	1.7	13.8	42.4	-	-	-	-	-	-	-	-
Sainfoin,	3	9.90	7.80	21.6	3.1	15.7	41.9	24.0	3.4	17.4	46.5	-	-	-	-	-	-	-	-
Sulla,	2	9.40	8.40	18.8	2.5	15.4	45.5	20.7	2.8	17.0	50.2	-	-	-	-	-	-	-	-
Hairy lotus,	2	11.50	7.30	17.5	2.6	13.1	48.0	19.8	2.9	14.8	54.2	-	-	-	-	-	-	-	-
Summer rape,	1	11.10	16.30	16.2	3.4	12.8	40.2	18.2	3.8	14.4	45.3	-	-	-	-	-	-	-	-

Winter rape,	1	10.10	20.00	11.1	2.8	13.7	42.3	12.3	3.1	15.2	47.0	-	-	-	-	-	-	-	-
Dwarf Essex rape,	1	7.70	14.90	17.5	3.5	11.9	44.5	19.0	3.8	12.9	48.2	-	-	-	-	-	-	-	-
Soja bean,	4	12.10	7.30	21.1	4.1	14.2	41.2	24.0	4.7	16.2	46.8	11.2	1.2	9.8	27.2	12.7	1.4	11.2	30.9
Cow pea,	3	9.60	8.40	19.6	3.7	15.5	43.2	21.7	4.1	17.1	47.8	8.4	1.9	10.1	28.6	9.3	2.1	11.1	30.3
Small pea,	1	5.80	5.90	31.0	1.4	15.6	40.3	32.9	1.5	16.6	42.7	-	-	-	-	-	-	-	-
Flat pea,	1	8.90	8.60	29.0	1.7	21.9	29.9	31.8	1.9	24.0	32.9	-	-	-	-	-	-	-	-
Serradella,	3	9.60	6.40	22.8	2.4	15.4	43.4	25.2	2.6	17.0	48.1	11.4	1.8	10.0	27.3	12.6	2.0	11.1	30.3
Hairy vetch,	1	7.40	7.80	29.5	1.1	18.2	36.0	31.9	1.2	19.6	38.9	-	-	-	-	-	-	-	-
Common vetch,	2	8.90	7.50	27.7	2.3	13.8	39.8	30.4	2.5	15.1	43.8	15.0	1.4	10.5	26.3	16.4	1.5	11.5	28.9
Scotch tares,	1	5.80	11.60	26.1	1.6	18.4	26.5	30.9	1.9	22.0	31.4	-	-	-	-	-	-	-	-
Vetch and oats (equal parts each),	2	9.40	8.20	27.7	2.6	15.4	36.7	30.6	2.9	17.0	40.4	-	-	-	-	-	-	-	-
Vetch and oats (proportion unknown),	3	11.70	6.80	28.9	2.7	8.5	41.4	32.7	3.1	9.6	46.9	19.1	.5	5.1	22.4	21.6	.6	5.8	25.3
Vetch, oats and horse bean,	1	10.20	9.30	27.0	2.4	17.0	34.1	30.1	2.7	18.9	37.9	-	-	-	-	-	-	-	-
Horse-bean straw,	1	9.10	8.70	37.6	1.4	8.9	34.3	41.4	1.5	9.7	37.8	14.7	.7	4.4	22.0	16.1	.8	4.8	24.2
Soja-bean straw,	3	11.40	6.40	37.6	1.9	4.9	37.8	42.4	2.2	5.5	42.7	14.3	1.1	2.5	24.9	16.1	1.3	2.8	28.2
White daisy (*Chrysanthemum*, etc.),	1	9.60	6.40	32.6	2.1	7.0	42.3	36.1	2.3	7.7	46.8	15.0	1.3	4.1	28.3	16.6	1.4	4.5	31.3
Dry carrot tops,	1	9.80	12.50	12.3	1.8	19.1	45.5	13.6	2.0	20.1	50.4	-	-	-	-	-	-	-	-
Wheat straw,	1	6.20	4.50	33.7	1.5	6.8	47.3	35.9	1.6	7.2	50.5	18.9	.5	1.2	20.3	20.1	.6	1.2	20.3
Barley straw,	2	10.00	5.10	34.1	2.6	6.9	42.3	36.8	2.9	7.7	47.0	19.1	1.1	1.4	22.8	20.6	1.2	1.5	25.4
Japanese millet (white head),	1	8.50	4.70	32.0	2.2	7.0	45.6	35.0	2.4	7.7	49.8	-	-	-	-	-	-	-	-
Japanese millet (red head),	1	8.90	3.10	36.0	1.5	5.3	45.2	39.5	1.7	5.8	49.6	-	-	-	-	-	-	-	-
Japanese millet hay,	1	18.30	6.90	25.7	1.8	3.7	43.6	31.4	2.2	4.5	53.5	-	-	-	-	-	-	-	-

A. Composition and Digestibility of Cattle Feeds — Continued.

NAME.	Analyses.	Composition. Fresh or Air-Dry Substance. Water.	Ash.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Composition. Water-Free Substance. Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Digestibility. Fresh or Air-Dry Substance. Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Digestibility. Water-Free Substance. Cellulose.	Fat.	Protein.	Nitrogen-free Extract.
II. Hay and Dry Coarse Fodders — Con.																			
Millet straw,	1	13.40	5.90	36.2	1.2	4.3	39.0	41.8	1.4	5.0	45.0	-	-	-	-	-	-	-	-
Straw (*Panicum crus-galli*),	1	12.60	4.70	31.4	2.1	5.3	43.9	35.9	2.4	6.1	50.2	-	-	-	-	-	-	-	-
Straw (*P. miliaceum*),	1	12.20	5.40	37.1	2.6	3.4	39.3	42.2	3.0	3.9	44.7	-	-	-	-	-	-	-	-
Straw (*P. Italicum*),	1	19.70	5.00	33.3	1.3	3.4	37.3	41.5	1.6	4.2	46.4	-	-	-	-	-	-	-	-
III. Roots, Bulbs, Tubers, etc.																			
Beets, red,	7	87.80	1.10	.7	.1	1.5	8.8	6.0	.9	12.3	72.2	.3	-	1.1	8.0	2.6	-	9.2	65.7
Beets, sugar,	12	85.40	.90	1.0	.1	1.6	11.0	6.6	.7	11.2	75.5	1.0	.05	1.1	10.0	6.6	.35	10.2	75.5
Beets, yellow fodder,	4	88.50	1.00	1.0	.2	1.3	8.0	8.1	1.4	11.7	69.3	.4	-	1.0	7.2	3.3	-	8.8	62.1
Mangolds,	5	87.90	1.20	.8	.1	1.4	8.6	8.5	1.0	9.5	71.0	-	-	1.1	7.8	-	-	7.1	64.6
Ruta-bagas,	3	89.10	1.10	1.3	.2	1.2	7.1	11.8	1.5	11.0	65.9	1.0	.10	1.0	6.7	8.7	1.20	8.8	62.6
Turnips,	5	89.60	.90	1.2	.2	1.1	7.0	11.7	1.8	10.6	67.4	1.2	.20	1.0	6.8	11.7	1.80	9.5	65.4
Carrots,	5	89.00	.90	1.1	.2	1.0	7.8	9.1	2.1	8.8	71.6	-	-	-	-	-	-	-	-

Parsnips,	1	80.40	1.50	1.5	.7	1.3	14.6	7.7	3.4	6.9	74.6	-	-	-	-	-	-	-	-
Potatoes,	14	81.00	1.00	.5	.1	1.9	15.5*	2.6	.5	10.0	81.5†	-	-	.8	14.1	-	-	4.4	74.2
Artichokes,	1	77.50	1.10	.9	.2	2.9	17.4	4.2	1.0	12.8	77.2	-	-	-	-	-	-	-	-
Japanese radish (*merinia*),	1	93.30	.70	.7	.1	.5	4.7	10.3	1.1	7.5	70.8	-	-	-	-	-	-	-	-
Japanese radish (*niyas-hige*),	1	92.60	.70	.7	.1	.5	5.4	9.9	1.0	6.5	72.7	-	-	-	-	-	-	-	-
IV. Grains, Seeds, Fruits, etc.																			
Corn kernels,	29	10.60	1.50	1.9	4.8	10.9	70.3	2.1	5.4	12.2	78.6	-	-	-	-	-	-	-	-
Sweet corn kernels,	1	12.00	1.40	2.1	8.4	11.1	65.0	2.4	9.6	12.6	73.8	-	-	-	-	-	-	-	-
Wheat kernels,	2	10.60	1.80	2.2	1.6	12.0	71.8	2.5	1.8	13.3	80.4	-	-	-	-	-	-	-	-
Oat kernels,	2	11.10	3.10	8.4	5.8	13.2	58.4	9.5	6.5	14.8	65.7	1.7‡	4.1	10.4	43.2	1.9	4.6	11.4	62.6
Broom-corn seed,	1	14.10	2.20	7.1	3.5	9.6	63.5	8.3	4.1	11.2	74.0	-	-	-	-	-	-	-	-
Soja beans,	4	13.00	5.10	5.0	17.2	31.2	28.5	5.7	19.8	35.9	32.8	3.6	14.8	28.4	21.7	4.0	17.0	32.7	24.9
Red adzinki beans,	2	15.90	3.50	3.9	.7	20.6	55.4	4.6	.8	24.5	65.9	2.8	.5	18.1	47.6	3.3	.6	21.6	56.7
Saddle beans,	1	12.40	5.40	4.2	14.5	13.2	50.3	4.8	16.6	15.1	57.3	-	-	-	-	-	-	-	-
Horse beans,	1	10.30	3.90	7.3	.9	26.9	40.7	8.1	1.1	30.0	56.5	5.2	7.7	23.7	37.8	5.8	.9	25.4	52.5
Millet seed,	3	13.30	2.60	7.7	3.7	11.4	61.3	8.9	4.3	13.2	70.6	-	-	-	-	-	-	-	-
Chestnuts,	1	44.90	1.50	1.4	8.0	7.3	36.9	2.5	14.5	13.3	67.0	-	-	-	-	-	-	-	-
Cranberries,	1	89.40	.20	1.2	.6	.5	8.1	11.6	5.6	4.4	76.4	-	-	-	-	-	-	-	-
Apples,	2	77.70	.70	1.5	.5	1.0	18.6	6.6	2.3	4.3	84.7	-	-	-	-	-	-	-	-

* Starch (14 determinations) = 12.9 per cent. † Starch (14 determinations) = 68.2 per cent. ‡ With horses.

A. *Composition and Digestibility of Cattle Feeds*—Continued.

NAME.	Analyses.	Composition.										Digestibility.							
		Fresh or air-dry substance.						Water-free substance.				Fresh or air dry substance.				Water-free substance.			
		Water.	Ash.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.
V. Flour and Meal.																			
Corn meal,	38	13.60	1.40	1.8	3.3	9.5	70.4	2.1	3.8	11.0	81.5	-	3.0	5.7	65.5	-	3.5	6.6	75.6
Corn and cob meal,	37	10.50	1.40	6.7	3.7	9.0	68.7	7.5	4.2	10.0	76.7	3.1	4.2	5.4	59.6	3.4	4.5	6.0	67.5
Cooked feed (oats and corn),	1	5.50	3.80	8.2	5.0	14.0	63.5	8.7	5.3	14.8	67.2	-	-	-	-	-	-	-	-
Hominy meal,	4	10.00	1.10	29.6	.5	3.2	55.6	32.9	.6	3.6	61.7	-	-	-	-	-	-	-	-
Wheat meal,	1	11.50	2.00	2.9	2.0	12.1	69.5	3.3	2.2	13.7	78.6	-	-	-	-	-	-	-	-
Ground oats,	2	9.30	3.50	8.5	3.6	11.4	63.7	9.3	4.0	12.6	70.2	4.2	3.2	8.0	58.5	4.6	3.6	8.8	64.5
Ground barley,	5	13.10	2.40	5.7	1.9	11.3	65.6	6.5	2.2	13.0	75.5	2.8	1.7	7.9	60.4	3.2	2.0	9.1	69.5
Broom-corn meal,	1	13.50	2.10	6.9	3.5	9.7	64.3	8.0	4.1	11.2	74.3	-	-	-	-	-	-	-	-
Pea meal,	1	8.80	2.60	17.7	1.6	19.2	50.1	19.4	1.7	21.0	55.0	11.7	1.2	17.1	46.6	12.8	1.2	18.6	51.1
Peanut meal,	1	8.00	4.00	3.5	10.8	49.0	25.7	3.8	11.7	53.3	26.9	.8	9.5	44.6	23.6	.9	10.4	48.5	24.7
"Red Dog" flour,	1	9.70	1.90	1.4	4.4	22.6	60.0	1.5	4.9	25.0	66.5	-	-	-	-	-	-	-	-
Bean meal,	1	12.00	1.40	2.1	8.5	11.0	65.0	2.4	9.6	12.6	73.8	1.5	7.3	9.7	60.4	1.7	8.3	10.9	68.6

VI. *By-products and Refuse.*																				
Linseed meal, old process,	8	9.70	6.20	7.8	6.6	33.1	36.6	8.6	7.3	36.7	40.5	4.4	5.9	29.5	28.6	4.9	6.5	32.7	31.6
Linseed meal, new process,	8	8.30	5.90	8.5	2.9	36.1	37.3	9.3	3.2	39.4	41.7	6.3	2.7	30.7	32.1	6.8	3.0	33.5	35.9
Cotton-seed meal,	32	8.00	6.90	6.84	10.74	41.62	25.9	7.44	11.68	45.24	28.11	2.2	10.0	36.6	16.54	2.38	10.86	39.8	18.0
Cotton-seed bran,	2	9.80	3.10	28.5	3.4	10.6	44.6	31.6	3.8	11.8	49.4	-	-	-	-	-	-	-	-
Wheat bran,	49	10.60	6.80	9.8	4.5	16.1	52.2	10.9	5.0	18.0	58.5	2.2	3.2	14.0	40.4	2.4	3.6	14.0	40.4
Spring wheat bran,	4	10.40	5.70	10.5	5.0	16.0	52.4	11.7	5.6	17.9	58.4	2.5	3.8	12.8	36.6	2.8	4.2	14.3	40.9
Winter wheat bran,	3	11.00	6.00	8.5	2.8	15.1	56.5	9.6	3.2	17.0	63.3	2.3	1.8	11.6	36.7	2.6	2.0	13.1	41.1
Wheat middlings,	9	10.30	5.10	6.8	4.8	15.7	57.3	7.6	5.3	17.5	63.9	2.4	4.1	13.1	50.4	2.7	4.5	14.9	56.2
Rye bran,	2	10.90	3.80	3.6	2.3	15.9	63.5	4.0	2.6	17.8	71.3	-	-	-	-	-	-	-	-
Rye middlings,	1	12.50	3.50	3.3	5.9	11.6	64.2	3.7	5.6	13.2	73.5	-	-	-	-	-	-	-	-
Oat middlings,	1	6.40	4.50	18.3	3.5	11.3	56.0	19.5	3.7	12.1	59.9	-	-	-	-	-	-	-	-
Pea bran,	1	7.10	3.10	42.9	1.1	9.6	36.2	46.2	1.2	10.3	39.0	-	-	-	-	-	-	-	-
Buckwheat middlings,	1	11.50	4.80	4.6	6.6	22.6	49.9	5.2	7.5	25.5	56.4	-	-	-	-	-	-	-	-
Gluten meal,	38	9.00	.90	3.3	8.3	27.3	51.2	3.6	9.1	30.0	56.3	1.0	7.3	23.7	46.6	1.2	8.0	26.1	51.2
Gluten meal (Chicago), old process,	3	9.20	.80	1.1	6.2	30.4	52.2	1.2	6.8	33.5	52.5	-	5.8	27.1	48.4	-	6.5	29.8	53.5
Gluten meal (Chicago), new process,	4	9.60	1.30	2.4	6.0	38.4	42.3	2.6	6.6	42.5	46.8	-	-	-	-	-	-	-	-
Gluten meal (King),	2	7.20	1.70	1.4	19.1	34.6	35.9	1.5	20.6	37.4	38.7	-	18.1	31.8	30.2	-	19.6	34.4	32.5
Gluten feed (Buffalo),	15	8.10	.90	6.8	11.9	23.0	49.3	7.4	12.9	25.0	53.7	5.4	9.6	19.6	39.9	5.9	10.4	21.3	43.5
Gluten feed (Pope),	1	14.00	.70	1.5	14.0	33.2	36.6	1.8	16.3	38.7	42.4	-	-	-	-	-		-	-
Gluten feed (Peoria),	4	7.20	1.20	7.6	12.4	20.5	51.1	8.2	13.4	22.1	55.0	6.0	9.8	17.0	46.0	6.4	10.6	18.3	49.5
Maize feed (Chicago),	5	8.20	.60	7.5	7.1	24.9	51.7	8.2	7.7	27.1	56.3	6.2	6.5	21.2	45.5	6.7	7.1	23.2	49.5

A. *Composition and Digestibility of Cattle Feeds* — Concluded.

NAME.	Analyses.	Composition. Fresh or Air-Dry Substance. Water.	Ash.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Composition. Water-Free Substance. Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Digestibility. Fresh or Air Dry Substance. Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Digestibility. Water-Free Substance. Cellulose.	Fat.	Protein.	Nitrogen-free Extract.
VI. By-products and Refuse — Concluded.																			
Starch feed (Pope),	1	5.50	.80	14.5	10.7	10.7	57.8	15.2	11.3	11.3	61.3	-	-	-	-	-	-	-	-
Atlas gluten meal,	2	9.90	1.10	11.1	12.8	34.3	30.8	12.3	14.2	38.1	34.2	-	12.9	25.0	25.9	-	11.6	27.8	28.7
Glucose feed (Richardson),	1	6.30	1.00	11.0	11.0	21.6	49.1	11.7	11.7	23.1	52.4	-	-	-	-	-	-	-	-
Corn germ meal,	1	9.30	7.60	8.3	10.7	25.7	38.4	9.2	11.8	28.3	42.4	-	-	-	-	-	-	-	-
Corn germ feed,	1	7.50	.80	13.0	11.3	10.0	57.4	14.1	12.2	10.8	62.0	-	-	-	-	-	-	-	-
Corn screenings,	1	11.10	2.10	2.9	4.0	7.4	72.5	3.3	4.5	8.3	81.5	-	-	-	-	-	-	-	-
Proteina (mixed feed),	4	8.40	2.50	10.0	6.6	21.7	50.8	10.9	7.2	23.7	55.5	-	-	-	-	-	-	-	-
Excelsior feed,	1	7.10	4.10	13.7	5.0	9.1	61.0	14.7	5.4	9.8	65.7	-	-	-	-	-	-	-	-
Oat feed,	10	7.50	4.90	13.0	4.3	11.8	58.5	14.1	4.7	12.5	63.4	-	-	-	-	-	-	-	-
Rye feed,	2	8.90	2.70	3.3	2.6	13.8	68.7	3.6	2.9	15.1	75.4	-	-	-	-	-	-	-	-
Cocoa-nut meal,	1	9.30	5.20	17.1	11.7	20.5	36.2	18.8	12.9	22.6	40.0	-	-	-	-	-	-	-	-
Rice meal,	1	9.90	8.40	5.7	13.2	11.6	51.2	6.3	14.6	12.9	56.1	1.5	11.2	7.3	44.0	1.6	12.4	8.1	48.9
Louisiana rice bran,	1	10.20	9.50	13.4	8.7	8.8	49.4	14.9	9.7	9.8	55.0	-	-	-	-	-	-	-	-
Peanut feed,	2	10.00	2.60	56.4	5.5	8.9	16.6	62.7	6.1	9.9	18.4	6.8	5.0	6.3	8.1	7.5	5.4	7.0	9.0

Peanut husks,	1	13.00	1.20	66.0	1.7	5.0	13.1	75.9	1.9	5.7	15.1	-	-	-	-	-	-	-	-
Bakery refuse,	1	13.30	10.10	.3	5.5	8.0	62.8	.4	6.4	9.2	72.4	-	-	-	-	-	-	-	-
Vinegar mash,	1	94.50	.20	.5	.5	.9	3.4	8.6	8.5	16.5	63.4	-	-	-	-	-	-	-	-
Refuse from starch works,	1	57.00	.40	3.2	4.4	9.6	25.4	7.5	10.2	22.4	59.0	-	-	-	-	-	-	-	-
Oat meal and barley refuse,	1	7.80	3.50	20.6	3.5	6.9	57.7	22.3	3.8	7.5	62.6	-	-	-	-	-	-	-	-
Glucose refuse,	1	6.70	1.10	4.5	9.9	19.7	58.0	4.8	10.6	21.1	62.3	-	-	-	-	-	-	-	-
Dried brewers' grain,	4	9.90	4.10	10.2	4.4	21.0	50.4	11.3	4.9	23.3	56.0	5.4	4.0	16.6	39.7	6.0	4.5	18.4	33.0
Malt sprouts,	1	15.40	5.30	12.5	3.3	23.0	40.5	14.8	3.9	27.2	47.8	4.3	3.3	18.4	27.9	5.0	3.9	21.6	33.0
Damaged wheat,	1	13.10	2.00	2.7	2.2	14.2	65.8	3.1	2.5	16.3	75.8	-	-	-	-	-	-	-	-
Cocoa dust,	1	7.10	6.30	5.5	24.1	14.4	42.6	5.9	25.9	15.5	45.9	-	-	-	-	-	-	-	-
Broom-corn waste,	1	8.70	4.50	35.9	.9	6.1	43.9	39.3	1.0	6.8	48.0	-	-	-	-	-	-	-	-
Refuse from cows' manger (ensilage),	6	72.90	2.60	9.4	.4	2.2	12.5	34.6	1.5	8.4	45.9	-	-	-	-	-	-	-	-
Cotton hulls,	3	10.00	2.70	41.5	2.5	4.4	39.0	46.1	2.8	4.8	43.3	19.5	2.2	.3	13.3	21.7	2.2	.4	17.7
Cotton-hull bran,	1	9.60	1.90	35.5	1.1	2.4	49.5	39.3	1.2	2.6	54.7	-	-	-	-	-	-	-	-
Apple pomace,	3	82.80	.40	2.9	.8	1.2	11.9	17.1	4.5	6.8	69.5	-	-	-	-	-	-	-	-
Apple-pomace silage,	1	85.30	.60	3.3	1.1	1.2	8.5	22.2	7.4	8.2	58.0	-	-	-	-	-	-	-	-
Sugar-beet pulp, from diffusion battery,	1	89.70	.10	2.5	.1	1.4	6.2	23.7	1.0	12.4	61.9	-	-	-	-	-	-	-	-
Sugar-beet refuse,	1	28.90	5.30	5.8	.3	8.6	51.1	8.1	.4	12.1	71.9	-	-	-	-	-	-	-	-
Corn cobs,	6	7.60	1.30	31.4	.5	2.7	56.5	34.0	.6	2.9	61.1	20.4	.3	.4	33.9	22.1	.3	.4	36.7
Palmetto root,	1	11.50	3.90	18.9	.4	3.4	61.9	21.3	.5	3.8	70.0	-	-	-	-	-	-	-	-

B. Fertilizing Ingredients in Fodder Articles.

[Figures equal percentages or pounds in 100.]

NAME.	Analyses.	Water.	Nitrogen.	Potassium Oxide.	Phosphoric Acid.	Valuation per 2,000 Pounds.*
I. Green Fodders.						
Fodder corn,	14	78.6	.41	.33	.15	$1 43
Fodder-corn ensilage,	7	80.2	.42	.39	.13	1 52
Corn and soja-bean ensilage,	1	71.0	.79	.44	.42	2 56
Millet and soja-bean ensilage,	5	75.8	.48	.5	.12	1 81
Millet ensilage,	3	73.8	.26	.62	.14	1 48
Sorghum,	7	82.2	.23	.23	.09	87
Mochi millet,	3	62.6	.61	.41	.19	2 06
Millet (*Panicum crus-galli*),	1	75.1	.46	.49	.11	1 70
Green oats,	3	83.4	.49	.38	.13	1 58
Green rye,	2	72.0	.30	.64	.12	1 48
Vetch and oats,	1	86.1	.24	.79	.09	1 93
Horse bean,	1	74.7	.68	.35	.08	2 06
Soja bean,	1	73.2	.29	.53	.15	1 37
Soja bean (early white),	1	66.6	.94	.91	.21	3 37
Soja bean (early green),	1	69.8	.84	.71	.20	2 92
Soja bean (medium black),	1	76.9	.80	.57	.18	2 74
Soja bean (late),	1	79.7	.60	.68	.14	2 26
Kidney vetch,	1	80.9	.56	.35	.09	1 78
Cow-pea vines,	1	78.8	.27	.31	.10	1 06
Prickly comfrey,	1	86.8	.37	.76	.12	1 77
Serradella,	2	82.6	.41	.42	.14	1 54
Common buckwheat,	1	84.7	.44	.54	.09	1 69
Flat pea (*Lathyrus sylvestris*),	1	78.6	1.05	.45	.14	3 14
Hungarian grass,	1	74.3	.39	.54	.16	1 54
White lupine,	1	85.4	.44	.25	.05	1 36
Yellow lupine,	1	85.1	.40	.44	.09	1 49
Spanish moss,	1	60.8	.28	.26	.03	96
II. Hay and Dry Coarse Fodders.						
English hay,	12	11.9	1.32	1.55	.30	5 02
Rowen,	13	18.5	1.63	1.50	.44	5 85
Timothy hay,	3	11.3	1.24	1.46	.34	4 78
Red top (*Agrostis vulgaris* With.),	4	7.7	1.15	1.02	.36	4 14

* The valuation is based on the following prices per pound of essential fertilizing ingredients: nitrogen, 12 cents; potassium oxide, 5 cents; phosphoric acid, 5 cents.

B. Fertilizing Ingredients in Fodder Articles — Continued.

NAME.	Analyses.	Water.	Nitrogen.	Potassium Oxide.	Phosphoric Acid.	Valuation per 2,000 Pounds.*
II. Hay and Dry Coarse Fodders — Con.						
Kentucky blue-grass (*Poa pratensis* L.),	2	5.3	1.32	1.69	.43	$5 29
Orchard grass,	4	8.8	1.31	1.89	.41	5 44
Meadow fescue,	6	8.9	.99	2.10	.40	4 87
Perennial rye-grass,	2	9.1	1.23	1.55	.56	5 06
Italian rye-grass,	4	8.7	1.19	1.27	.56	4 69
Salt hay,	1	5.4	1.18	.72	.25	3 80
Japanese millet (white head),	3	10.5	1.11	1.22	.40	4 28
Common buckwheat,	1	8.5	2.62	3.21	.53	10 02
Silver-hull buckwheat,	1	8.9	1.78	2.38	.86	7 51
Japanese buckwheat,	1	5.7	1.63	3.32	.85	8 08
Fodder corn,	7	7.9	1.76	.89	.54	5 65
Corn stover,	17	9.3	1.04	1.38	.29	4 17
Teosinte,	1	6.1	1.46	3.70	.55	7 75
Summer rape,	1	11.1	2.05	4.67	.57	10 16
Millet hay,	1	9.8	1.28	1.69	.49	5 25
Mammoth red clover,	3	11.4	2.23	1.22	.55	7 12
Medium red clover,	2	7.9	2.18	2.29	.45	7 97
Alsike clover,	6	9.9	2.34	2.23	.67	8 52
Lucerne (alfalfa),	4	6.3	2.08	1.46	.53	6 98
Bokhara clover,	2	7.4	1.98	1.83	.56	7 14
Blue melilot,	1	8.2	1.92	2.80	.54	7 95
Sainfoin,	1	12.2	2.63	2.02	.76	9 09
Sulla,	2	9.4	2.46	2.09	.45	8 36
Lotus villosus,	2	11.5	2.10	1.81	.59	7 44
Soja bean,	2	6.3	2.32	1.08	.67	7 32
Cow pea,	1	9.0	1.64	.91	.53	5 38
Small pea,	1	5.8	2.50	1.99	.59	8 58
Flat pea (*Lathyrus sylvestris*),	1	8.9	3.51	2.34	.82	11 58
Serradella,	2	7.4	2.70	.65	.78	7 91
Scotch tares,	1	15.8	2.96	3.00	.82	10 92
Spring vetch,	1	8.2	2.20	2.76	.74	8 78
Vetch and oats,	3	9.9	1.30	1.35	.56	5 03
Soja-bean straw,	1	13.0	.71	1.06	.26	3 02
Millet straw,	1	13.5	.69	1.76	.18	3 58

* See note on page 260.

B. Fertilizing Ingredients in Fodder Articles — Continued.

NAME.	Analyses.	Water.	Nitrogen.	Potassium Oxide.	Phosphoric Acid.	Valuation per 2,000 Pounds.*
II. Hay and Dry Coarse Fodders — Con.						
White daisy,	1	9.7	.28	1.25	.44	$2 36
Dry carrot tops,	1	9.8	3.13	4.88	.61	13 00
Barley straw,	2	10.0	1.13	2.41	.22	5 34
III. Roots, Bulbs, Tubers, etc.						
Beets, red,	8	87.8	.23	.44	.09	1 08
Beets, sugar,	4	87.0	.22	.48	.10	1 12
Beets, yellow fodder,	1	90.6	.19	.46	.09	1 01
Mangolds,	3	87.6	.15	.34	.14	84
Ruta-bagas,	3	89.1	.19	.49	.12	1 07
Turnips,	4	89.7	.17	.38	.12	81
Carrots,	3	89.0	.16	.46	.09	93
Parsnips,	1	80.3	.22	.62	.19	1 34
Potatoes,	4	80.1	.29	.51	.08	1 29
Artichokes,	1	77.5	.46	.48	.17	1 74
Japanese radish (*merinia*),	1	93.3	.08	.28	.05	52
Japanese radish (*niyas hige*),	1	92.6	.08	.34	.05	58
IV. Grains, Seeds, Fruits, etc.						
Corn kernels,	13	10.9	1.82	.40	.70	5 46
Corn and cob meal,	29	9.0	1.41	.47	.57	4 42
Oat kernels,	1	9.0	2.10	–	–	–
Soja beans,	2	18.3	5.30	1.99	1.87	16 58
Red adzinki beans,	1	14.8	3.24	1.54	.94	10 26
White adzinki beans,	1	16.9	3.33	1.48	.97	10 44
Saddle beans,	1	12.3	2.12	2.13	1.52	8 74
Japanese millet,	1	13.7	1.73	.38	.69	5 22
Common millet,	1	12.7	2.04	.36	.85	6 11
Chestnuts,	1	44.9	1.18	.63	.39	3 85
Cranberries,	1	89.4	.08	.10	.03	32
Apples,	2	79.9	.13	.19	.01	66
V. Flour and Meal.						
Corn meal,	3	14.1	1.92	.34	.71	5 66
Hominy feed,	1	8.9	1.63	.49	.98	5 38
Ground barley,	1	13.4	1.55	.34	.66	4 72
Wheat flour,	2	12.1	2.02	.36	.35	5 56

* See note on page 260.

B. Fertilizing Ingredients in Fodder Articles — Concluded.

NAME.	Analyses.	Water.	Nitrogen.	Potassium Oxide.	Phosphoric Acid.	Valuation per 2,000 Pounds.*
V. Flour and Meal — Con.						
Pea meal,	1	8.9	3.08	.99	.82	$9 20
Soja-bean meal,	1	10.8	5.89	2.23	1.57	17 94
Peanut meal,	1	8.0	7.84	1.54	1.27	21 63
VI. By-products and Refuse.						
Linseed meal (old process),	4	8.0	5.39	1.21	1.78	15 93
Linseed meal (new process),	5	7.9	5.83	1.25	1.69	16 93
Cotton-seed meal,	24	8.2	6.70	1.83	2.47	20 38
Wheat bran,	10	9.9	2.36	1.40	2.10	9 16
Wheat middlings,	2	10.2	2.75	.75	1.25	8 60
Rye middlings,	1	12.5	1.84	.81	1.26	6 47
Rye feed,	1	9.6	1.95	.98	1.56	7 22
Gluten meal,	5	8.5	5.09	.05	.42	12 69
Gluten feed (Buffalo),	5	8.2	3.72	.06	.34	9 31
Gluten meal (Chicago),	2	9.6	5.75	.06	.43	14 29
Gluten meal (King),	1	7.8	5.69	.08	.69	14 43
Dry distillery feed (Atlas),	1	11.2	5.30	.16	.23	13 50
Dry brewers' grain,	2	8.6	2.68	.85	1.05	8 33
Proteina,	1	10.1	2.97	.57	1.00	8 70
Damaged wheat,	1	13.1	2.26	.51	.83	6 76
Louisiana rice bran,	1	10.3	1.43	.84	1.71	5 98
Glucose refuse,	1	6.7	3.37	.09	.61	8 09
Cocoa dust,	1	7.1	2.30	.63	1.34	7 49
Broom-corn waste (stalks),	1	10.4	.87	1.86	.46	4 41
Cotton hulls,	3	10.6	.75	1.08	.18	3 06
Peanut feed,	2	10.0	1.46	.79	.23	4 52
Peanut husks,	1	13.0	.80	.48	.13	2 53
Meat meal,	1	8.0	11.21	.30	.73	27 93
Apple pomace,	2	80.5	.23	.13	.02	70
Corn cobs,	8	12.1	.50	.60	.06	1 86
Palmetto roots,	1	11.5	.54	1.38	.16	2 83
Buckwheat hulls,	1	11.9	.49	.52	.07	1 77
VII. Dairy Products.						
Buttermilk,	1	91.1	.51	.05	.04	1 31
Skim-milk,	22	90.3	.59	-	-	-
Whey,	1	93.7	.10	.07	.17	48

* See note on page 260.

C. *Analyses of Dairy Products (Per Cent.).*

	Analyses.	Solids. Maximum.	Solids. Minimum.	Solids. Average.	Fat. Maximum.	Fat. Minimum.	Fat. Average.	Curd.	Salt.	Ash.
Whole milk,	1,993	18.27	10.20	13.47	7.54	1.72	4.14	-	-	-
Skim-milk,	351	10.48	7.68	9.48	1.02	.05	.32	-	-	-
Buttermilk,	31	9.86	6.83	8.33	.38	.11	.27	-	-	-
Cream (from Cooley process),	197	32.78	18.12	26.10	25.00	10.53	17.66	-	-	.62
Cream (concentrated commercial),	2	50.12	48.71	49.41	45.37	44.33	44.85	-	-	-
Butter (salted),	38	92.89	85.35	89.21	89.05	81.43	84.34	1.18	3.69	-
Butter (fresh),	14	85.36	72.49	82.24	85.05	72.21	81.48	.76	-	-
Whole-milk cheese (Jersey),*	1	-	-	62.84	-	-	37.32	22.13	-	3.39
Whole-milk cheese,*	1	-	-	64.17	-	-	34.34	26.69	-	3.14
Cheese from milk skimmed after twelve hours' standing,*	1	-	-	62.70	-	-	27.81	30.37	-	4.52
Cheese from milk skimmed after twenty-four hours' standing,*	1	-	-	57.76	-	-	23.42	31.99	-	2.35
Cheese from milk skimmed after thirty-six hours' standing,*	1	-	-	56.05	-	-	17.67	33.24	-	5.14
Cheese from milk skimmed after forty-eight hours' standing,*	1	-	-	54.59	-	-	15.77	34.94	-	3.88
Cheese from skim-milk, with addition of buttermilk,*	1	-	-	51.62	-	-	18.35	28.63	-	4.64
Genuine oleomargarine cheese,*	1	-	-	62.10	-	-	31.66	25.94	-	4.50

* From analyses made in 1875.

Tables of the Digestibility of American Feed Stuffs.

Experiments made in the United States.

Compiled by J. B. LINDSEY.

I. Experiments with Ruminants.
II. Experiments with Swine.

Dec. 31, 1895.

TABLES OF THE DIGESTIBILITY OF AMERICAN FEED STUFFS.

I. Experiments with Ruminants.

KIND OF FODDER.	Number of Different Samples.	Number of Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).
Hay and Dry Coarse Fodders.								
Timothy hay (in bloom),	3	5	55.6—65.7 60	56.4—66.8 60	55.8—62.1 58	51.5—61.8 57	50.3—60.4 56	57.5—71.8 63
Timothy hay (past bloom),	5	10	47.0—61.1 53	48.4—62.3 54	37.2—56.8 47	34.6—61.1 53	38.8—50.4 45	55.6—66.9 60
Timothy hay (average all trials),	11	25	57	58	52	60	48	63
Hay of mixed grasses (medium in protein*),	1	2	-	-	49	50	40	58
Hay of mixed grasses (rich in protein),	4	14	54—62 58	- -	56—66 60	44—57 49	56—64 59	56—63 59
Rowen (mixed grasses),	1	4	- -	63—67 65	65—68 66	44—50 46	68—70 69	63—68 65
Rowen (chiefly timothy),	1	4	- -	62—67 64	62—73 66	48—51 49	66—69 68	60—65 63
Average (both samples),	-	-	-	65	66	47	68	64
Salt hay of black grass (*Juncus Gerardi*),	1	2	57—62 60	- -	57—64 60	37—46 41	62—63 63	53—59 56
High-grown salt hay (largely *Spartina juncea*),	1	2	51—55 53	- -	46—55 50	42—51 47	62—63 63	52—55 53
Branch grass (*Spartina juncea*, with *Spartina stricta*, var. *glabra*),	1	2	55—57 56	- -	48—56 52	27—36 31	61—63 62	54—55 54
Low meadow fox grass (*Spartina juncea*),	1	2	52—54 53	- -	49—53 51	17—30 24	- 57	51—52 52

Meadow, swale or swamp hay,	1	2	38—40 39	- -	30—36 33	- 44	31—37 34	- 46
Hay of vetch and oats,	1	2	58—58 58	- -	65—67 66	17—20 19	60—61 60	54—54 54
Clover and timothy hay (poorly cured),	1	2	54.3—55.3 55	- -	52—54.4 53	- 58	37.5—37.9 38	- 60
Hungarian hay,	1	2	64.3—65.8 65	65.9—66.8 66	66.8—68.5 68	- 64	- 60	66.9—67.4 67
Hay of blue-joint grass (past bloom) (*Calamagrostis Canadensis*),	1	1	40	42	37	37	57	43
Hay of blue-joint grass (bloom),	1	2	66.7—70.5 69	68.1—71.5 70	71.5—73.4 72	51.4—53.3 52	68.2—72.3 70	66.4—70.9 69
Hay of orchard grass (ten days after bloom),	1	1	54	56	58	54	59	54
Hay of orchard grass (stage not given),	1	2	57.5—60 59	- -	60—66.7 64	55.4—57.4 56	60—60.8 60	55.3—57.3 56
Average of both samples,	2	3	56	56	61	55	60	55
Hay of red top,	2	3	57.6—62.3 60	59.3—63.6 61	60.8—61.8 61	44.2—58.8 51	60.4—62.4 61	59.1—65.2 62
Dried pasture grass,	1	1	71	-	77	60	72	73
Oat straw,	1	2	49—51.7 50	50.8—53.2 52	57.2—58 58	35.5—41 38	- -	51.8—54.6 53
Barley hay,	1	4	59	62	62	41	65	63
Hay of Legumes.								
Soja bean hay,	1	2	61.9—62.7 62	- -	59.5—62.1 61	18.7—39.7 29	70.1—72.1 71	66.1—71.5 69
Peanut-vine hay,	1	2	59.5—60.2 60	- -	51.2—52.6 52	62.1—69.8 66	63—63.6 63	69.3—69.7 70

* Below 10 per cent.

Table of the Digestibility of American Feed Stuffs — Continued.

KIND OF FODDER.	Number of Different Samples.	Number of Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).
Hay of Legumes — Concluded.								
Cow-pea-vine hay (fair quality),	1	2	- 59	- -	41.2—44.6 43	46.4—53.7 50	63.9—65.1 65	- 71
Clover hay (late bloom, fair quality),	1	2	54.4—55.5 55	55.9—56.4 56	43.8—49 46	51.8—54.8 53	49.3—59.1 55	63.3—64.8 64
Clover hay (good quality),	1	2	50.8—53.5 52	51.6—54.3 53	46.6—49 48	40—48 43	47—52.2 49	56.8—58.9 58
White clover hay (bloom),	1	1	66	67	61	51	73	70
Scarlet clover hay (*T. incarnatum*),	2	6	56.8—65.4 62	- -	32—58.1 41	35.1—54 44	64—70 66	52—73.6 60
Alsike clover (*T. hybridum*),	2	3	61.1—64.3 62	62—65.2 63	51—58.7 53	35.1—69.3 50	64—69.2 66	66.5—74.1 71
Alfalfa (lucerne) (late bloom),	1	2	-	-	49	54	77	64
Alfalfa (lucerne) (stage not given),	1	1	-	-	43	48	69	72
Corn Fodder (partially Air Dry).								
Corn stover (whole plant),	1	4	61.1—62 62	- -	64.8—68.3 67	48.1—55.8 52	49.6—54.8 52	62.5—64.5 64
Corn stover (tops and blades),	1	2	59—60.5 60	- -	71.1—71.7 71	70.6—71.9 71	54.2—56.6 55	61.9—62.6 62
Corn stover (leaves of),	1	2	54.8—56.2 56	- -	54.3—67 61	60.6—65.4 63	43.1—68.8 56	57.1—60.6 59

Corn stalk (below ear),	1	2	64—69 67	- -	71—75 74	79—80 80	15—27 21	65—73 69
Topped stover (part above ear),	1	2	52—58 55	- -	69—72 71	62—65 64	17—27 22	50—57 54
Corn husks,	1	2	71—73 72	- -	78—81 80	23—42 33	24—35 30	75 -
Corn leaves (below ear),	1	2	62—67 65	- -	75—80 78	52—59 56	28—41 35	66—70 68
Flint corn fodder (ears just forming),	1	3	69—72 70	71—73 71	72—73 72	63—71 67	69—73 70	71—73 71
Flint (mature) field corn fodder,	4	9	68—73 71	71—75 73	69—80 76	59—77 70	59—79 65	69—78 73
Dent (mature) field corn fodder,	5	10	63—70 68	- -	43—61 54	72—82 78	43—61 53	68—81 76
Average both kinds,	-	-	70	-	65	74	59	74
Dent (in milk) field corn fodder,	5	11	58.8—66 63	- -	50—71 64	67—79 75	44—51 50	61—69 66
Dent (immature, Burrill and Whitman, coarse),	1	4	51—64 57	- -	45—74 59	66—84 76	20—36 27	57—66 61
Dent (immature, no ears formed),	4	8	61—70 65	63—71 67	63—77 71	59—72 66	57—67 62	57—70 64
Sweet corn fodder (mature),	3	6	60—71 67	62—74 70	70—77 74	63—71 74	54—73 64	57—73 68
Miscellaneous Dry Substances.								
Hay of wild oat grass (*Danthonica spicata*),	2	3	59.6—68.3 64	61.2—69.1 65	65.1—70.6 68	38.2—62.8 50	48.6—68 58	62.1—68.8 65
Hay of witch grass (*Triticum repens*),	2	4	59.9—62.7 61	61—64.3 62	56.4—67.6 62	53.6—60 57	49.5—64.2 58	62.1—69.9 66
Hay of buttercups (*Ranunculus acris*),	1	2	56	57	41	70	56	67

Table of the Digestibility of American Feed Stuffs — Continued.

KIND OF FODDER.	Number of Different Samples.	Number of Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent).	Crude Protein (Per Cent).	Extract Matter (Per Cent).
Miscellaneous Dry Substances — Concluded.								
Hay of white weed (*Leucanthemum vulgare*),	1	2	58	58	46	62	58	67
Cat's-tail millet (*Pennesetum spicatum*),	1	2	61.1—63.6 62	– –	64.7—68.4 67	44.7—47.6 46	60.6—64.6 63	58.3—60 59
Johnson-grass hay,	1	1	55	–	58	39	45	54
Sorghum fodder (leaves),	1	2	59.9—66.3 63	– –	64.9—75.9 70	46.3—47.1 47	59.5—62.2 61	62.5—66.6 65
Sorghum bagasse,	1	1	61	–	64	46	14	65
Cotton-seed hulls (fed alone),	4	13	35—47.5 41	– –	.54—57.6 47	58.2—89.3 79	.00—24.6 6	12.9—45.7 34
Cotton-seed hulls when fed with cotton-seed meal (7 to 1 and 6 to 1),	1	3	41 –	– –	33—40 38	– 78	– –	48—50 49
Cotton-seed hulls when fed with cotton-seed meal (4 to 1 to 1½ to 1),	3	11	43—48 45	– –	43—50 46	66—80 76	– –	49—57 51
Cotton seed feed (hulls and meal, 7 to 1 and 6 to 1),	1	3	45--46 46	– –	34—40 37	81—82 82	44—46 45	50—51 50
Cotton-seed feed (hulls and meal, 4 to 1 to 1½ to 1),	3	11	52—56 55	– –	43—49 46	84–86 85	61—65 62	49—56 54
Green Fodders.								
Dent corn fodder (immature),	4	11	64—74 68	– –	60—76 67	37—83 68	56—80 66	64—79 71
Dent corn fodder (in milk),	3	9	70	–	64	78	61	76

Dent corn fodder (glazing),	5	9	67	-	51	78	54	75
Dent corn fodder (mature),	2	4	65	-	55	73	51	72
Average (glazing and mature),	7	13	66	-	52	76	53	74
Dent corn fodder (ears glazing, Burrill and Whitman, coarse),	1	2	51—54 52	- -	46—47 46	74—82 78	20—28 24	87—61 59
Sweet corn fodder (milk),	1	2	77—78 77	- -	74—76 75	73—74 74	77—78 77	80—81 81
Early amber sorghum (just after blossom),	1	2	60.9—61.7 61	- -	41.7—45.3 42	·67 -	37.7—42.5 40	70.4—70.8 71
Sorghum in blossom (variety not stated),	1	2	73.1—73.3 73	- -	74—75 75	81.3—81.6 81	51.1—55.7 53	78.2—78 78
Average both samples,	2	4	67	-	59	74	46	74
Green grass (young),	1	1	69	-	74	55	65	72
Same (dry),	1	1	71	-	77	60	71	73
Pasture grass,	1	2	71.9—75.6 74	- -	74.6—76.5 76	74—74.9 74	74—76.5 75	73.8—77.1 75
Average of three samples,	-	-	71	-	76	63	70	73
Soiling barley (full bloom),	1	2	- -	62—71 66	49—64 56	61—63 62	69—71 70	69—76 73
Barley and peas (full bloom),	1	2	- -	55—65 60	55—65 60	38—49 44	73—81 77	56—67 61
Soiling rye (formation of head),	1	2	73.2—74 74	- -	78.9—80.4 80	73.6—74.8 74	78 6—79.7 79	69.7—71.4 71
Hungarian grass (probably in bloom),	1	4	61—67 63	63.4—68.8 66	65.4—71.7 68	47.8—56 52	59.4—66.4 62	63.5—68.4 66
Soiling clover (late blossom),	1	2	64.9—67.3 66	- -	52.3—52.9 53	63—66.1 65	65.8—68.3 67	76.1—79.3 78

Table of the Digestibility of American Feed Stuffs — Continued.

KIND OF FODDER.	Number of Differ-eut Samples.	Number of Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).
Green Fodders — Concluded.								
Scarlet clover (late bloom),	1	3	- -	68—70 69	54—58 56	63—69 66	- 77	74—75 74
Average two samples clover,	2	5	66	67	55	66	73	77
Corn Silage.								
Dent silage (immature),	5	13	60—68 64	- -	71—78 70	64—85 71	42—65 54	60—70 66
Dent silage (milk),	4	12	60—74 65	- -	45—80 64	78—90 87	45—63 52	63—73 69
Dent silage (average of both),	9	26	65	-	68	79	53	67
Dent silage (stage uncertain, North Carolina),	1	4	53—67 60	- -	43—64 56	55—79 70	19—34 24	61—76 68
Flint silage (ears glazing),	4	11	68—78 75	66—80 77	75—79 77	- 82	48—73 65	71—83 79
Fine crushed silage (steers),	1	2	60.4—68 64	- -	72—78 75	75—77 76	32—44 38	60—70 65
Fine crushed silage (sheep),	1	2	51.5—56 54	- -	59.5—67.7 64	67.5—69 68	21—22 21.5	52.6—57.3 55
Corn silage (raw, ears mature),	1	1	-	-	59	86	45	71
Same (cooked),	1	1	-	-	70	87	39	75
Sweet corn ensilage (occasional ears mature),	1	2	66.6—69.6 68	68.5—71.7 70	68.4—73.7 71	82.3—84.6 83	52.7—55.2 54	70.7—73 72
Soja-bean ensilage,	1	2	52.2—65.8 59	- -	47.1—62.5 55	66.4—77.3 72	71.3—80.2 76	45.9—58.2 52

Roots, Tubers, etc.								
Potatoes,	1	3	73.3—80.1 77	74.6—81.2 78	- -	13 -	43.4—45.4 44	87.3—93.4 91
Sugar beets,	1	2	94.2—94.8 95	97.6—99.9 99	88.5—113 100	46.4—53.5 50	90—92.6 91	99.8—100 100
Mangolds,	1	2	77.1—80 79	82.7—87 85	26.8—58.8 43	- -	69.7—79.8 75	90.8—91.9 91
English flat turnips,	1	2	90.7—94.9 93	93.2—99 96	89.2—117 100	82.5—92.5 98	84.5—95 90	96—97 97
Ruta-bagas,	1	2	84.4—90 87	89.2—93 91	61—87.5 74	76.8—91.6 84.2	74.7—85.9 80.3	94.4—95.1 95
Grains and Seeds.								
Corn meal (maize),	2	5	83—98 88	- -	- -	80—98 92	40—77 60	85—100 93
Corn and cob meal,	1	3	74—83 79	- -	2—86 45	82—85 84	43—65 52	86—91 88
Pea meal,	1	2	85—88 87	86—89 88	25—26 26	52—57 55	80—86 83	93—94 94
Raw cotton seed,	1	2	63—69 66	- -	65—86 76	- 87	66—70 68	49—50 50
Roasted cotton seed,	1	2	53—58 56	- -	62—69 66	68—75 72	44—50 47	50—53 51
Soja-bean meal,	1	2	75—82 79	- -	28—50 50	81—90 85	89—91 90	71—73 72
Cotton-seed meal,	2	6	67—82 76	- -	- 32	87—100 93	83—96 88	44—75 64
By-products.								
Gluten meal,	1	2	85—90 87	86—92 89	- 33	86—90 88	83—90 87	88—94 91
Chicago gluten meal,	1	2	87—89 88	- -	- -	92—94 93	87—91 89	93—94 93

Table of the Digestibility of American Feed Stuffs — Concluded.

KIND OF FODDER.	Number of Different Samples	Number of Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).
By-products — Concluded.								
King gluten meal,	1	2	79—82 81	- -	- -	91—97 94	- 91	78—81 79
Average gluten meals,	3	6	85	-	-	92	89	88
Buffalo gluten feed (one lot),	1	2	76—80 78	- -	40—46 43	81—82 81	84—86 85	78—84 81
Buffalo gluten feed (another lot),	1	2	87—88 87	- -	84—94 89	92—95 93	87—87 87	87—87 87
Peoria gluten feed,	1	2	84—87 86	- -	59—97 78	76—82 79	81—85 83	90—90 90
Chicago maize feed,	1	2	83—85 84	- -	68—76 72	90—90 90	83—84 84	84—87 85
Winter-wheat bran,	1	3	57—66 62	- -	00—56 27	51—80 64	75—79 77	62—76 65
Spring-wheat bran,	1	2	62—63 63	- -	22—25 24	76—76 76	78—82 80	70—71 70
Average all wheat brans,	4	9	60	63	22	71	78	68
Wheat middlings,*	1	2	72.6—72.2 75	75.1—79.3 77	- -	84.1—86.1 85	78.4—79.4 79	80.7—84.5 83
Wheat middlings,*	1	2	79.48—85.63 83	- -	32.57—40.06 36	81.71—87.98 85	81.83—87.75 85	84.43—91.08 88
New-process linseed meal,	1	3	73—83 80	- -	49—100 74	90—98 93	86—88 85	82—87 84
Old-process linseed meal,	1	3	75—82 79	- -	38—71 57	85—92 89	86—93 89	76—79 78

Atlas meal,	1	2	80—80 80	- -	95—116 106	90—92 91	73—73 73	84—85 84
Rye meal,	1	2	85—90 87	- -	- -	63—65 64	83—85 84	89—94 92
Peanut feed,	1	2	32—32 32	- -	10—13 12	89—90 90	70—71 71	41—58 49
Malt sprouts,	1	1	67	68	34	100	80	69
Dried brewers' grains,	1	2	62—62 62	- -	50 —55 53	89—93 91	78—81 79	59—59 59
Corn cobs,	1	2	59—60 59	- -	65—66 65	44—56 50	13—22 17	60—60 60

II. Experiments with Swine.

Maize kernels (whole),	1	1	83	83	38	46	69	89
Maize meal,	2	2	89.5—89.7 90	91.3—92.1 92	29.4—48.7 39	77.6—81.7 80	86.1—89.9 88	93.9—94.2 94
Maize meal (with cobs),	1	1	76	77	29	82	76	84
Pea meal,	1	1	90	92	78	50	89	95
Barley meal,	1	1	80	80	49	57	81	87
Wheat (whole),	1	?	72	-	30	60	70	74
Wheat (cracked),	1	?	82	-	60	70	80	83
Wheat shorts,	1	2	74—79 77	- -	25—48 37	- -	71—75 73	85.5—88 87
Wheat bran,	1	2	53.7—68.6 61	- -	29.6—39.1 34	65.4—78.1 72	74.4—75.8 75	56—75 66

* Probably different products.

LITERATURE.

The following publications have been consulted in compiling the tables of the digestibility of American feed stuffs: —

Report of Storrs School (Connecticut) Experiment Station, 1894.

Reports of the Maine State Experiment Station for 1886, 1887, 1888, 1889, 1890, 1891, 1893, 1894.

Reports of the New York Experiment Station, 1884, 1888, 1889.

Reports of the Pennsylvania Experiment Station, 1887, 1888, 1889, 1890, 1891, 1892, 1893.

Bulletins Nos. 80 *c*, 81, 87 *d*, 97 and 118 of the North Carolina Experiment Station.

Bulletin No. 16, Utah Experiment Station.

Bulletin No. 3 of the Wisconsin Experiment Station for 1884, and Sixth Annual Report, 1889.

Bulletin No. 8 of the Colorado Experiment Station.

Bulletins Nos. 26 and 36 of the Minnesota Experiment Station.

Bulletin No. 6 of the Oregon Experiment Station.

Bulletins Nos. 13, 15 and 19 of the Texas Experiment Station.

Bulletin No. 20 of the Maryland Experiment Station.

Eleventh and Twelfth Annual Reports (1893 and 1894) of the Massachusetts State Experiment Station.

Report of Hatch Experiment Station, 1895.

REPORT OF THE CHEMIST.

DEPARTMENT OF FERTILIZERS AND FERTILIZER MATERIALS.

CHARLES A. GOESSMANN.

Part I. On Field Experiments.

1. Experiments to study the effect of raising leguminous crops in rotation with grain crops on the nitrogen sources of the soil.
2. Observations with mixed forage crops as fodder supply.
3. Experiments to study the economy of using natural phosphates in place of acid phosphates (superphosphates).
4. Experiments to ascertain the influence of different mixtures of chemical fertilizers on the character and yield of garden crops.
5. Experiments to study the effect of phosphatic slag and nitrate of soda as compared with ground bones on field crops.
6. Experiments to study the effect of rotation of manures on permanent grass lands.

Part II. On the Work in the Chemical Laboratory.

1. Report on inspection of commercial fertilizers.
2. Report on general work in the laboratory.
3. Compilation of analyses of manurial substances.
4. Compilation of analyses of fruits, garden crops and insecticides.

PART I.

REPORT ON FIELD EXPERIMENTS.

CHARLES A. GOESSMANN.

1. FIELD EXPERIMENTS CARRIED ON FOR THE PURPOSE OF STUDYING THE EFFECT OF A LIBERAL INTRODUCTION OF CLOVER-LIKE PLANTS — LEGUMINOUS CROPS — INTO FARM PRACTICE, AS A MEANS OF INCREASING THE RESOURCES OF AVAILABLE NITROGEN PLANT FOOD IN THE SOIL UNDER CULTIVATION. (*Field A.*)

The observation of the fact that the different varieties of clover and of clover-like plants in general, as peas, beans, vetches, lupines, etc., are in an exceptional degree qualified, under favorable conditions, to convert, by the aid of certain micro-organisms of the soil, the elementary nitrogen of the air into plant food, imparts to that class of farm crops a special interest from an economical standpoint. This circumstance is in a controlling degree due to the two following causes: —

First. — The nitrogen-containing soil constituents of plant food are as a rule in a high degree liable to suffer serious changes in regard to their character and fitness as well as in reference to their quantity.

Second. — Available nitrogen-furnishing manurial substances are the most costly articles of plant food in our markets.

Field experiments which propose to show by their results to what extent the cultivation of clover-like plants can be relied on as a practical and economical means for securing efficiently nitrogen plant food for the crops to be raised have

deservedly of late engaged the most careful attention of agricultural investigators.

The experiments in part described within a few subsequent pages were planned in 1883, and have been continued to the present time upon the same field, with such modification as circumstances advised.

The investigations have been divided into three periods: —

(*a*) Study of the existing soil resources of plant food, 1884 to 1889.

(*b*) Study of the effect of excluding nitrogen plant food from outside sources and of adding nitrogen plant food in various available forms, 1889 to 1892.

(*c*) Studying the effect of the cultivation of leguminous crops on the resources of available nitrogen plant food in the soil under treatment, 1892 to 1896.

The systematic treatment of the field here under consideration, as far as suitable modes of cultivation and of manuring are concerned, was introduced during the season of 1883 to 1884.

The subdivision of the entire area into eleven plats, "one-tenth of an acre each," of a uniform size and shape, 132 feet long and 33 feet wide, with an unoccupied and unmanured space of 5 feet in width between adjoining plats, has been retained unaltered since 1884. A detailed statement of the temporary aim and general management of the experiments, as well as of the results obtained in that connection from year to year, forms a prominent part of my contemporary printed annual reports, to which I have to refer for further details, 1884–95. The first four years of the stated period 1884–89 were principally devoted to an investigation into the general character and condition of the soil under cultivation, as far as its natural and inherent resources of available phosphoric acid, nitrogen and potash were concerned. *The soil proved to be in particular deficient in potash.* Different varieties of corn (maize) were raised in succession to assist in the investigation.

Since 1889 the main object of observation upon the same field has been to study the influence of an entire exclusion of any additional nitrogen-containing manurial substance

from the soil under cultivation, as well as of a definite additional supply of nitrogen in different forms of combination on the character and yield of the crop selected for the trial.

Several plats (4, 7, 9) which for five preceding years (1883 to 1889) had not received any nitrogen compound for manurial purposes were retained in that state, to study the effect of an entire exclusion of nitrogen-containing manurial substances on the crop under cultivation; while the remaining ones received, as before, a definite amount of nitrogen in the same form in which they had received it in preceding years, namely, either as sodium nitrate (1, 2), as ammonium sulphate (5, 6, 8), as organic nitrogenous matter in form of dried blood (3, 10) or of barn-yard manure (0). A corresponding amount of available nitrogen was applied in all these cases.

Plats.	Annual Supply of Manurial Substances.
Plat 0,	800 lbs. of barn-yard manure, 32 lbs. of potash-magnesia sulphate and 18 lbs. of dissolved bone-black.
Plat 1, .	29 lbs. sodium nitrate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 2, .	29 lbs. sodium nitrate (= 4 to 5 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 3, .	43 lbs. dried blood (= 5 to 6 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 4, .	25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 5, .	22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 6, .	22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 7, .	25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 8, .	22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 9, .	25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 10, .	43 lbs. dried blood (= 5 to 6 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).

Amount of Fertilizing Ingredients used Annually per Acre.

Plats 0, 1, 2, 3, 5, 6, 8, 10,	Nitrogen,	45 pounds
	Phosphoric acid,	80 pounds.
	Potassium oxide,	125 pounds.
Plats 4, 7, 9,	Nitrogen,	none.
	Phosphoric acid,	80 pounds.
	Potassium oxide,	125 pounds.

The mechanical preparation of the soil, the incorporation of the manurial substances, the seeding, cultivating and harvesting, were carried on year after year in a like manner, and as far as practicable on the same day in case of every plat during the same year.

Kind of Crops raised.

Corn (maize),	in 1889.
Oats,	in 1890.
Rye,	in 1891.
Soja bean,	in 1892.

The annual yield of the various crops upon the different plats showed that as a rule those plats (4, 7, 9) which had not received in any form nitrogen for manurial purposes yielded much smaller crops than those that annually received in some form or other an addition of a corresponding amount of available nitrogen.

The results of four years of careful observation were expressed in the following conclusion: —

The experiments carried on upon Field A during the years 1889, '90, '91 and '92 show conclusively the importance of a liberal supply to the soil of an available form of nitrogen to secure a successful and remunerative cultivation of farm crops under otherwise corresponding favorable conditions. For even a leguminous crop, the soja bean, when for the first time raised upon Field A, did not furnish an exception to our observation (1892). (For details, see report for 1892.)

Subsequent to the year 1892, when for the first time in the more recent history of the field under discussion a leguminous crop, a late-maturing variety of soja bean, had been

raised upon it, our attention had been directed chiefly to the question, To what extent does the cultivation of soja bean, a clover-like plant, benefit the resources of available nitrogen plant food of the soil after the removal of the crop at the close of the season (for ensilage)?

It seemed of interest in our case to ascertain whether the raising of the soja bean upon Field A had increased the amount of available nitrogen stored up in the soil to such an extent as to affect the yield of succeeding crops upon those plats (4, 7, 9) which, as a rule, did not receive at any time for eight successive years an addition of available nitrogen from any other manurial source but the atmospheric air and the roots left in the soil after harvesting the crops raised.

A grain crop (oats) was selected as the crop suitable to serve for that purpose. The general management of the experiment, as far as the preparation of the soil, manuring and seeding-down are concerned, was the same as in preceding years (see tenth annual report).

An examination of the yield of the crop in 1893, secured upon the different plats, showed that the total crop per acre on those plats to which no nitrogen was applied (4, 7, 9) averaged 800 pounds less than in case of the plats which received their regular supply of nitrogen in some form or other.

Ratio of Grain to Straw (1893).

Plat 0,	1:3	Plat 6,	1:4.9
Plat 1,	1:4.1	Plat 7,	1:3.6
Plat 2,	1:3.1	Plat 8,	1:3.4
Plat 3,	1:3.2	Plat 9,	1:3.4
Plat 4,	1:2.7	Plat 10,	1:3.9
Plat 5,	1:7		

The best results in relation of total yield to yield of grain were obtained in case of those plats receiving organic nitrogen (dried blood and barn-yard manure) or nitrogen in the form of nitrate of soda; while in the case of sulphate of ammonia the ratio of grain to straw was too wide to be satisfactory.

The total yield of crops on the plats receiving no nitro-

gen addition, as compared with those receiving a nitrogen supply, was during succeeding years as follows: —

With corn in 1889, one-fifth less.

With oats in 1890, one-fifth to one-sixth less.

With rye in 1891, one-fifth to one-sixth less.

With soja bean in 1892, one-third to one-fourth less.

With oats in 1893, one-seventh to one-eighth less.

From these results it appeared that the introduction of a leguminous crop into our rotation had somewhat reduced the difference in yield between the plats receiving no nitrogen and those receiving it, yet had not entirely obliterated it. It was decided to continue the observation by repeating the raising of soja beans in 1894 and oats in 1895.

1894. — To secure, if possible, more decisive results regarding the presence and absence of available nitrogen, it was decided to use twice the amount of phosphoric acid and potassium oxide, as compared with preceding years.

Amount of Fertilizing Ingredients applied per Acre during 1894.

Plats 0, 1, 2, 3, 5, 6, 8, 10,	Nitrogen,	45 pounds.
	Phosphoric acid,	160 pounds.
	Potassium oxide,	250 pounds.
Plats 4, 7, 9,	Nitrogen,	none.
	Phosphoric acid,	160 pounds.
	Potassium oxide,	250 pounds.

An early-maturing variety of soja bean was selected for the experiments. The fertilizer mixtures were applied as in previous years, broadcast, in the middle of April.

After proper preparation of the soil the soja beans were planted on May 12 in drills two and one-half feet apart, 6 pounds of seed being used per plat, or 60 pounds per acre. The plants appeared above ground May 21; June 5 the field was cultivated and hoed, and also on the 16th, 25th and July 12.

The plants began to bloom July 25. Owing to the protracted drought of July and August, the crop did not get that fulness of growth which might have been obtained under more favorable conditions. The crop was cut August 28.

Yield of Soja Bean when cut on Different Plats (1894).

[Pounds.]

PLATS.	Per Plat.
Plat 0,	600
Plat 1,	625
Plat 2,	700
Plat 3,	525
Plat 4,	405
Plat 5,	645
Plat 6,	615
Plat 7,	480
Plat 8,	680
Plat 9,	470
Plat 10,	570

	Per Cent.
Dry matter,	34
Moisture,	66

Conclusions.

1. A comparison of the above-stated yield of the different plats shows that those plats (4, 7, 9) which received no nitrogen addition from an outside source yielded on an average 452 pounds each, while those plats which received an addition of available nitrogen plant food, 45 pounds of nitrogen per acre, yielded on an average 620 pounds each, — a difference of one-third in favor of the latter.

2. An increase to twice the amount of phosphoric acid and potassium oxide, as compared with earlier years (see report for 1892), had not changed the relative yield of the crop, as noticed in case of the late soja bean in 1892.

1895. — Oats were again selected to succeed the soja bean of the preceding season, for the purpose of admitting a direct comparison of the results of 1894 and 1895 with those obtained under corresponding circumstances during the years 1892 and 1893, when the same crops followed each other in the same order.

The field was ploughed April 29; the fertilizers were applied April 30, in the same manner and in the same quantity to each plat as in the preceding year (1894), specified upon a previous page, namely, per acre: —

Plats 4, 7, 9,	Nitrogen,	None.
	Phosphoric acid,	160 pounds.
	Potassium oxide,	250 pounds.
Plats 0, 1, 2, 3, 5, 6, 8, 10,	Nitrogen,	45 pounds.
	Phosphoric acid,	160 pounds.
	Potassium oxide,	250 pounds.

The oats were sown in drills two feet apart, at the rate of 7 pounds per plat, or 70 pounds per acre, on May 7. The young plants showed above ground on all plats alike May 11.

To secure clean culture the cultivator was used twice, May 29 and June 12. The crop did not mature at the same time upon all plats, and was for that reason cut at different dates. It was cut when matured, on August 2 upon plats 0, 1, 2, 3, 4, 7, 9, 10, on August 8 upon plats 5 and 8 and on August 17 upon Plat 6. From this data it will be noticed that in all cases where sulphate of ammonia was used as the nitrogen supply for the raising of oats the maturing of the crop was from one to two weeks later than on all other plats, where either nitrate of soda or organic nitrogen compounds, as blood, barn-yard manure or no nitrogen-containing manurial matter, was applied. Similar results have been noticed in previous years, when summer grain crops have been raised in connection with the experiment under discussion.

Yield of Field A, Oats (1895).

[Pounds.]

PLATS.	Oats.	Straw.	Total Weight.
Plat 0,	134	254	388
Plat 1,	160	330	490
Plat 2,	150	330	480
Plat 3,	149	331	480
Plat 4,	110	233	343
Plat 5,	190	360	550
Plat 6,	155	405	560
Plat 7,	136	292	428
Plat 8,	92	458	550
Plat 9,	123	217	340
Plat 10,	169	381	550

	Per Cent.
Moisture, oats,	14.60
Moisture, straw,	15.90

Summary of Yield of Oats (1893, 1895).

[Pounds.]

PLATS.	1893.			1895.		
	Weight of Grain.	Weight of Straw and Chaff.	Total Weight.	Weight of Grain.	Weight of Straw and Chaff.	Total Weight.
Plat 0,	131	399	530	134	254	388
Plat 1,	135	555	690	160	330	490
Plat 2,	146	454	600	150	330	480
Plat 3,	166	534	700	149	331	480
Plat 4,	160	430	590	110	233	343
Plat 5,	79	551	630	190	360	550
Plat 6,	102	498	600	155	405	560
Plat 7,	119	431	550	136	292	428
Plat 8,	95	325	420	92	458	550
Plat 9,	110	370	480	123	217	340
Plat 10,	125	485	610	169	381	550

Ratio of Grain to Straw (1893, 1895).

PLATS.	1893.	1895.
Plat 0,	1:3	1:1.9
Plat 1,	1:4.1	1:2.06
Plat 2,	1:3.1	1:2.2
Plat 3,	1:3.2	1:2.2
Plat 4,	1:2.7	1:2.1
Plat 5,	1:7	1:1.9
Plat 6,	1:4.9	1:2.6
Plat 7,	1:3.6	1:2.14
Plat 8,	1:3.4	1:4.97
Plat 9,	1:3.4	1:1.76
Plat 10,	1:3.9	1:2.25

Average Yield of Oats on Plats receiving no Nitrogen and on Plats receiving Nitrogen (1893, 1895).

[Pounds.]

PLATS.	1893.	1895.
Plats 4, 7 and 9 (no nitrogen),	540.0	370.3
Plats 0, 1, 2, 3, 5, 6, 8 and 10 (receiving nitrogen),	597.5	506.0

Conclusions.

The conditions of the different plats are apparently materially the same to-day as they were two years ago. The raising of soja beans has not changed the results for the better. It remains to be seen whether the ploughing under of a leguminous crop, serving as green manure, will affect the results.

2. Observations with the Cultivation of Mixed Forage Crops. (*Field B.*)

The importance of a more liberal supply of nutritious forage crops for an economical support of dairy stock is quite generally recognized by all parties interested. To assist in the solution of that question induced the writer to devote for a series of years special attention to the raising of fodder crops of a high nutritive character and of a liberal yield. Mixed forage crops, consisting of early maturing annual leguminous crops, clover-like plants and of either oats or barley, suggested themselves for a trial; for they attain a high feeding value at a comparatively early period of the season, — towards the end of June when in bloom; they can serve with benefit in form of green fodder, hay or ensilage, as circumstances advise, and they yield under fair conditions large quantities. Experiments with peas, Scotch tares and vetches have been already described in previous reports. The results obtained induced the writer to prefer summer vetch (*vicia sativa*) to both peas and tares, in case of mixed crops. The fields used for the observation were located in different parts of the farm; they were as a rule in a fair state of cultivation, as far as the mechanical condition of the soil as well as its store of plant food was concerned. The soil consisted in the majority of cases of a somewhat gravelly loam.

Vetch and Oats.

1893. — Half an acre of a field which had served during the preceding year for the production of root crops, carrots and sugar beets was fertilized April 26 with 300 pounds of fine-ground bone and 100 pounds of muriate of potash. The fertilizer was applied broadcast and subsequently ploughed in May 8; the field was sown with oats and summer vetch, using 2 bushels of oats and 25 pounds of vetch. The seeds were sown each by itself, on account of the great difference in size and general character. The crop made an even and rapid growth. The oats headed out at the time when the vetch began to bloom. At this stage of growth the feeding as green fodder began, July 6. It was continued until the oats

turned yellowish, July 18. The remainder of the crop was then cut for hay. The total yield of the crop, counted as green fodder, with 20 per cent. of dry vegetable matter, amounted to 21,000 pounds per acré. Buckwheat was subsequently raised upon the same field as fall crop.

1894. — The field in this case was 700 feet long and 75 feet wide, equal to one and one-fifth acres (corn was raised upon it in 1893). It was ploughed Oct. 25, 1893, and manured with barn-yard manure at the rate of ten tons per acre; and was ploughed again April 18, 1894, and harrowed and subsequently seeded with oats and vetch, as described in the preceding experiment, using 4 bushels of oats and 45 pounds of vetch per acre. The seeds were, however, sown at two different times, to extend the period of the fitness of the crop for green fodder. The seed sown on the northern portion April 20 came up April 28. The southern portion of the field was seeded May 11, the plants appearing above ground May 19. The crop made a very satisfactory growth, and on June 23 the feeding of the green material from the northern portion began (the vetch being in bloom and the oats heading out), continuing until July 2, when the remainder was cut for hay. July 6 the cutting from the southern portion began, continuing until the 18th, when that remaining was cut for hay. Following is given a statement of the yield from the field: —

	Pounds.
Green material fed (19.12 per cent. of dry matter), .	6,875
Hay of vetch and oats (73.66 per cent. of dry matter),	4,980

July 21 the field was ploughed and prepared for raising upon it, as a fall crop, Hungarian grass.

During the same year (1894) other observations of a similar character as previously described were carried on in other parts of the farm.

It was decided to compare the effect of muriate of potash and sulphate of potash on mixed crops, consisting of oats and vetch and of barley and vetch. The field used for this observation consisted of a light loam. It had been used during the preceding season for the cultivation of different varieties of potatoes, and had received as manure on that occasion, per acre, in one case, 400 pounds of high-grade

sulphate of potash (95 per cent.), with 600 pounds of fine-ground bone; in the other, 400 pounds of muriate of potash (80–82 per cent.), with 600 pounds of fine-ground bone. The same amount and kind of manure were applied for raising vetch and oats and vetch and barley. The field occupied by these crops was ploughed, manured, harrowed and seeded down, as far as practicable, at the same time. The seed was sown in all cases April 26. Four bushels of oats with 45 pounds of vetch were sown, as on previous occasions, while 3 bushels of barley were used, with 45 pounds of vetch, in case of barley and vetch. Both crops came up May 4, and were of a uniformly healthy condition during their subsequent growth. The barley began to head out June 20; the vetch was at that time beginning to bloom. The crop was cut for hay June 23.

Yield of Barley and Vetch per Acre.

In case of muriate of potash and bone, . .	5,737 pounds of hay.
In case of sulphate of potash and bone, . .	5,077 pounds of hay.

The oats headed out June 25; the vetch was fairly in bloom. The crop was cut for hay July 2.

Yield of Oats and Vetch per Acre.

In case of muriate of potash and bone, . .	8,051 pounds of hay.
In case of sulphate of potash and bone, . .	7,088 pounds of hay.

1895. — During that year the observations of the preceding year were repeated and in some directions enlarged upon. Aside from mixed forage crops of vetch and oats and vetch and barley, there were raised crops consisting of oats, vetch and horse bean and of oats and lentils. The field used for these experiments had been used during the preceding season either for the cultivation of potatoes or of vetch and oats. In both cases it had been manured, per acre, with either 400 pounds of muriate of potash and 600 pounds of fine-ground bone, or with 400 pounds of sulphate of potash and 600 pounds of fine-ground bone. The same kind and the same quantity of manure were applied in 1895. The field was ploughed April 25; the manure harrowed in

May 3; the seed was sown broadcast May 9. All parts of the field were treated alike, and as far as practicable on the same day. The plats occupied by the crops were in all cases 33 feet wide, with 4 feet unoccupied space between them, and from 191 to 241 feet long. The yield of areas 175 feet long and 33 feet wide, running along by the side of each other, served as our basis for comparing results (5,775 square feet).

The seed was sown May 9, at the rate of 4 bushels of oats and 45 pounds of vetch per acre. The oats came up May 16, and the vetch May 21; the former headed out July 6, and the vetch began blooming at that time. The crop was cut for hay July 16.

Yield of Vetch and Oats per Acre.

In case of muriate of potash and bone, ...	7,238 pounds.
In case of sulphate of potash and bone, ...	6,635 pounds.

Vetch, Horse Bean and Oats.

The seed was sown May 9, at the rate of 40 pounds of vetch, 120 pounds of horse bean (medium sized) and 3 bushels of oats. The oats came up May 16, the vetch on May 21 and the horse bean May 23. The crop appeared healthy and vigorous at every stage of growth. It was cut for hay July 22, when the oats were fairly headed and the remainder in bloom.

Yield of Vetch, Horse Bean and Oats per Acre.

In case of muriate of potash and bone, ...	7,398 pounds.
In case of sulphate of potash and bone, ...	5,881 pounds.

Lentils and Oats.

The seed was sown May 9, at the rate of 60 pounds of lentils and 4 bushels of oats per acre. The oats came up May 16, and the lentils on May 21; the former headed out July 6, when the latter were fairly in bloom. The crop was cut for hay July 16. The experiment was confined to a trial with sulphate of potash and bone as manure on account of want of a suitable field.

Yield of lentils and oats per acre, ...	5,881 pounds of hay.

Composition of Mixed Forage Crops raised, 1893 to 1896.

Green crop when cut contains: —

Moisture,	76 to 80 per cent.
Dry matter,	20 to 24 per cent.

Analyses of Vetch and Barley (Equal Number of Plants of Each).

[Per Cent.]

	Muriate of Potash.	Sulphate of Potash.
Moisture at 100° C.,	78.23	77.70
Dry matter,	21.77	22.30
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	4.64	7.80
" fibre,	32.25	32.58
" fat,	2.12	2.56
" protein,	14.44	13.36
Nitrogen-free extract matter,	46.55	43.70
	100.00	100.00

Analyses of Vetch and Oats (Equal Number of Plants of Each).

[Per Cent.]

	Muriate of Potash.	Sulphate of Potash.
Moisture at 100° C.,	76.24	75.29
Dry matter,	23.76	24.71
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	9.59	8.69
" fibre,	29.83	31.28
" fat,	3.13	2.63
" protein,	18.88	15.16
Nitrogen-free extract matter,	38.57	42.24
	100.00	100.00

Analysis of Vetch, Oats and Horse Bean (Muriate of Potash).

[Three plants each of vetch and of oats and one of horse bean.]

	Per Cent.
Moisture at 100° C.,	82.13
Dry matter,	17.87
	100.00

Analysis of Dry Matter.

Crude ash,	10.36
" cellulose,	30.07
" fat,	2.70
" protein,	18.93
Nitrogen-free extract matter,	37.94
	100.00

Analysis of Lentils and Oats.

	Per Cent.
Moisture at 100° C.,	78.50
Dry matter,	21.50
	100.00

Analysis of Dry Matter.

Crude ash,	5.40
" cellulose,	34.90
" fat,	2.40
" protein,	14.90
Nitrogen-free extract matter,	42.40
	100.00

Conclusions.

From the above analyses it appears that vetch and oats lead vetch and barley, on account of the larger and more foliaceous character of the oats as compared with the barley. Vetch, oats and horse bean lead in nitrogenous matter, and no doubt will exceed in regard to the nutritious character of the crop as soon as the amount of horse bean has been doubled, as indicated above. Every one of these crops compares well with clover hay, as far as its nutritive value is concerned. The large yield of these crops per acre, their high nutritive value and special adaptation for green fodder, hay or ensilage, merit serious attention for the support of farm and dairy stock. The early date of maturity presents exceptionally good chances of raising a second crop for fall supply of fodder, or for a timely preparation of the soil for winter crops. Feeding experiments carried on for several years at the station with these crops have fully established their high nutritive character for dairy stock, as well as other farm live stock ordinarily depending on the product of the meadow and pasture.

3. Field Experiments with Different Commercial Phosphates, to study the Economy of using the Cheaper Natural Phosphates or the More Costly Acidulated Phosphates. (*Field F.*)

The field selected for this purpose is 300 feet long and 137 feet wide, running on a level from east to west. Previous to 1887 it was used as a meadow, which was well worn out at that time, yielding but a scanty crop of English hay. During the autumn of 1887 the sod was turned under and left in that state over winter. It was decided to prepare the field for special experiments with phosphoric acid by a systematic exhaustion of its inherent resources of plant food. For this reason no manurial matter of any description was applied during the years 1887, 1888 and 1889.

The soil, a fair, sandy loam, was carefully prepared every year by ploughing during the fall and in the spring, to improve its mechanical condition to the full extent of existing circumstances. During the same period a crop was raised every year. These crops were selected, as far as practicable, with a view to exhaust the supply of phosphoric acid in particular. Corn, Hungarian grass and leguminous crops (cow-pea, vetch and serradella) followed each other in the order stated.

1890. — The field was subdivided into five plats, running from east to west, each 21 feet wide, with a space of 8 feet between adjoining plats. The manurial material applied to each of these five plats contained, in every instance, the same form and the same quantity of potassium oxide and of nitrogen, while the phosphoric acid was furnished in each case in the form of a different commercial phosphoric-acid-containing article, namely, phosphatic slag, Mona guano, Florida phosphate, South Carolina phosphate (floats) and dissolved bone-black. The market cost of each of these articles controlled the quantity applied, for each plat received the same money value in its particular kind of phosphate. The phosphatic slag, Mona guano, South Carolina phosphate and Florida phosphate were applied at the rate of 850 pounds per acre, dissolved bone-black at the rate of 500 pounds per acre. Nitrate of soda was applied at the rate of 250 pounds

per acre and potash-magnesia sulphate at the rate of 390 pounds per acre.

Cost per Ton.

Phosphatic slag,	$15 00
Mona guano (West Indies),	15 00
Florida rock phosphate,	15 00
South Carolina phosphate (floats),	15 00
Dissolved bone-black,	25 00

Analyses of Phosphates used.

[I., phosphatic slag; II., Mona guano; III., Florida phosphate; IV., South Carolina phosphate; V., dissolved bone-black.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture,	0.47	12.52	2.53	0.39	15.96
Ash,	–	75.99	89.52	–	61.46
Calcium oxide,	46.47	37.49	17.89	46.76	–
Magnesium oxide,	5.05	–	–	–	–
Ferric and aluminic oxides,	14.35	–	14.25	5.78	–
Total phosphoric acid,	19.04	21.88	21.72	27.57	15.82
Soluble phosphoric acid,	–	–	–	–	12.65
Reverted phosphoric acid,	–	7.55	–	4.27	2.52
Insoluble phosphoric acid,	–	14.33	–	23.30	0.65
Insoluble matter,	4.39	2.45	30.50	9.04	6.26

The following fertilizer mixtures have been applied annually, from 1890 to 1894, to all the plats, with the exception of Plat 3, which received in 1890 ground apatite and in 1891 no phosphate whatever, on account of the failure of securing in time apatite suitable for the trial.

Plats.	Annual Supply of Manurial Substances.	Pounds.
Plat 1 (south, 6,494 square feet),	Ground phosphatic slag,	127
	Nitrate of soda,	43
	Potash-magnesia sulphate,	58
Plat 2 (6,565 square feet),	Ground Mona guano,	128
	Nitrate of soda,	43½
	Potash-magnesia sulphate,	59
Plat 3 (6,636 square feet),	Ground Florida phosphate,	129
	Nitrate of soda,	44
	Potash-magnesia sulphate,	59
Plat 4 (6,707 square feet),	South Carolina phosphate,	131
	Nitrate of soda,	44½
	Potash-magnesia sulphate,	60
Plat 5 (6,778 square feet),	Dissolved bone-black,	78
	Nitrate of soda,	45
	Potash-magnesia sulphate,	61

The field was ploughed as a rule during the month of October, and again at the close of the month of April. The fertilizer was in each case applied broadcast soon after ploughing in the spring. The seed was sown in hills or drills, as circumstances advised, and the crop kept clean from weeds by the use of the hoe or the cultivator. The following crops were raised: —

1890, potatoes (see eighth annual report).
1891, winter wheat (see ninth annual report).
1892, serradella (see tenth annual report).
1893, Dent corn, Pride of the North (see eleventh annual report).

Summary of Yield of Crops (Pounds).

PLATS.	1890. Potatoes.	1891. Wheat.	1892. Serradella.	1893. Corn.
Plat 1, phosphatic slag,	1,600	380	4,070	1,660
Plat 2, Mona guano,	1,415	340	3,410	1,381
Plat 3, Florida phosphate,	1,500	215	2,750	1,347
Plat 4, South Carolina floats,	1,830	380	3,110	1,469
Plat 5, dissolved bone-black,	2,120	405	2,920	1,322

Having for four years (1890–94) in succession pursued the above-stated system of manuring each plat with a different kind of phosphate, yet of corresponding money value, it was decided to continue the experiments for the purpose of studying the after-effect of the different phosphates on the crops to be raised. To gain this end the phosphates were hereafter in all cases entirely excluded from the fertilizers applied; in addition to this change, the former amount of potash and nitrogen was increased one-half in quantity, to favor the highest effect of the stored-up phosphoric acid of the soil under treatment.

The fertilizers hereafter to be used had the following composition: —

Plat 1 (6,494 square feet),	64½ pounds of nitrate of soda. 87 pounds of potash-magnesia sulphate.
Plat 2 (6,565 square feet),	65¼ pounds of nitrate of soda. 88 pounds of potash-magnesia sulphate.
Plat 3 (6,636 square feet),	66 pounds of nitrate of soda. 89 pounds of potash-magnesia sulphate.
Plat 4 (6,707 square feet),	66¾ pounds of nitrate of soda. 90 pounds of potash-magnesia sulphate.
Plat 5 (6,778 square feet),	67½ pounds of nitrate of soda. 90½ pounds of potash-magnesia sulphate.

The results of two seasons (1894 and 1895) are as follows: —

Barley.

Yield of Crop (1894).

Plats.	Grain and Straw (Pounds).	Grain (Pounds).	Straw and Chaff (Pounds).	Percentage of Grain.	Percentage of Straw.
Plat 1, ...	490	169	221	34.49	65.51
Plat 2, ...	405	148	251	34.07	65.93
Plat 3, ...	290	78	212	26.89	73.11
Plat 4, ...	460	144	216	31.30	68.70
Plat 5, ...	390	118	272	30.26	69.74

Rye.

Yield of Crop (1895).

Plats.	Grain and Straw (Pounds).	Grain (Pounds).	Straw and Chaff (Pounds).	Percentage of Grain.	Percentage of Straw.
Plat 1, ...	695	195	500	28.06	71.94
Plat 2, ...	631	166	465	26.31	73.69
Plat 3, ...	383	143	240	37.34	62.66
Plat 4, ...	759	189	570	24.90	75.10
Plat 5, ...	625	185	440	29.60	70.40

Summary of Yield of Crop (1890 to 1896).

[Pounds.]

Plats.	1890. Potatoes.	1891. Wheat.	1892. Serradella.	1893. Corn.	1894. Barley.	1895. Rye.
Plat 1, ...	1,600	380	4,070	1,660	490	695
Plat 2, ...	1,415	340	3,410	1,381	405	630
Plat 3, ...	1,500	215	2,750	1,347	290	383
Plat 4, ...	1,830	380	3,110	1,469	460	759
Plat 5, ...	2,120	405	2,920	1,322	390	625

Conclusions.

From the previous statement of comparative yield we find that the plat receiving dissolved bone-black leads in yield during the two first years, while for the third, fourth, fifth and sixth years the plats receiving insoluble phosphates are ahead, phosphatic slag being first, South Carolina floats second and Mona guano third.

The following statement regarding the amount of phosphoric acid applied in the case of each plat, and also the amount removed from them by the crops raised, shows approximately how much of the former is still stored up in the soil in each plat.

Phosphoric Acid applied to and removed from Field (Pounds).

PLATS.	1890. Potatoes. Added.	1890. Potatoes. Removed.	1891. Wheat. Added.	1891. Wheat. Removed.	1892. Serradella. Added.	1892. Serradella. Removed.	1893. Corn. Added.	1893. Corn. Removed.	Total Amount added.	Total Amount removed.	Total Amount remaining.
Plat 1, .	24.18	2.56	24.18	1.23	24.18	8.95	24.18	7.20	96.72	19.94	77.78
Plat 2, .	28.01	2.36	28.01	1.19	28.01	7.50	28.01	6.33	72.04	17.38	54.66
Plat 3, .	109.68	2.40	–	.69	28.01	6.05	28.01	5.95	165.70	15.09	150.61
Plat 4, .	36.12	2.93	36.12	1.31	36.12	6.84	36.12	6.68	144.48	18.12	126.36
Plat 5, .	12.34	3.39	12.34	1.22	12.34	6.42	12.34	6.05	49.36	17.08	32.28

Phosphoric Acid applied to and removed from Field (Pounds) — Concluded.

PLATS.	1894. — Barley. Added.	1894. — Barley. Removed.	1895. — Rye. Added.	1895. — Rye. Removed.	Total Amount added.	Total Amount removed.	Total Amount remaining.
Plat 1, ...	None.	1.92	None.	3.41	96.72	25.27	72.45
Plat 2, ...		1.64		3.04	72.04	22.06	49.98
Plat 3, ...		.76		2.06	165.70	17.91	147.79
Plat 4, ...		1.72		3.61	144.48	23.45	121.03
Plat 5, ...		1.49		3.11	49.36	21.68	27.68

The amount of phosphoric acid left in the soil at the close of the season of 1895 is lowest in Plat 5, where dissolved bone-black, the most costly phosphate used in the experiment, has served as its source. The experiment will be continued until a final answer is obtained.

4. Field Experiments to ascertain the Influence of Different Mixtures of Commercial Fertilizers on the Yield and General Character of Several Prominent Garden Crops.

The area devoted to the above-stated experiment is 198 feet long and 183 feet wide; it is subdivided into six plats of uniform size ($89\frac{1}{2}$ by 62 feet, or about one-eighth of an acre each). The plats are separated from each other and from the adjoining cultivated fields by a space of 5 feet of unmanured and unseeded yet cultivated land. They are arranged in two parallel rows, running from west to east. Nos. 1, 2 and 3 are along the north side of the field, beginning with No. 1 at its west end, while plats Nos. 4, 5 and 6 are located along its south side, beginning with Plat 4 on the west end. The soil is several feet deep, and consists of a light, somewhat gravelly loam, and was in a fair state of productiveness when assigned for the experiment here under consideration. The entire field occupied by the experiment is nearly on a level. Potatoes and a variety of forage crops had been raised upon it in preceding years. The manure applied since 1885 has consisted exclusively of fine-ground bone and muriate of potash, annually, 600 pounds of the former and 200 pounds of the latter per acre.

The observation with raising garden crops, by the aid of different mixtures of commercial manurial substances, here under special consideration, began upon plats Nos. 4, 5 and 6 during the spring of 1891, and upon plats 1, 2 and 3 during that of 1892.

The difference of the fertilizers applied consisted in the circumstance that different forms of nitrogen and potash were used for their preparation. All plats received essentially the same quantity of nitrogen, potash and phosphoric acid, and every one of them received its phosphoric acid in the same form, namely, dissolved bone-black. Some plats received their nitrogen supply in the form of organic animal matter, dried blood; others in the form of sodium nitrate, Chili saltpetre; others in the form of ammonium sulphate. Some plats received their potash in the form of muriate of potash (plats 1, 2, 3), and others (plats 4, 5, 6) in the form of the

highest grade of potassium sulphate (95 per cent.). The subsequent tabular statement shows the quantities of manurial substances applied to the different plats: —

Plats.	Annual Supply of Manurial Substances.	Pounds.
Plat 1,	Sulphate of ammonia,	38
	Muriate of potash,	30
	Dissolved bone-black,	40
Plat 2,	Nitrate of soda,	47
	Muriate of potash,	30
	Dissolved bone-black,	40
Plat 3,	Dried blood,	75
	Muriate of potash,	30
	Dissolved bone-black,	40
Plat 4,	Sulphate of ammonia,	38
	Sulphate of potash,	30
	Dissolved bone-black,	40
Plat 5,	Nitrate of soda,	47
	Sulphate of potash,	30
	Dissolved bone-black,	40
Plat 6,	Dried blood,	75
	Sulphate of potash,	30
	Dissolved bone-black,	40

This proportion corresponds per acre to: —

	Pounds.
Phosphoric acid (available),	50.4
Nitrogen,	60.0
Potassium oxide,	120.0

A computation of the results of a chemical analysis of twenty prominent garden crops shows the following average relative proportion of the three above-stated ingredients of plant food: —

	Per Cent.
Nitrogen,	2.2
Potassium oxide,	2.0
Phosphoric acid,	1.0

One thousand pounds of green garden vegetables contain, on the above-stated basis of relative proportion of essential constituents of plant food: —

	Pounds.
Nitrogen,	4.1
Potassium oxide,	3.9
Phosphoric acid,	1.9

The weights and particular stage of growth of the vegetables when harvested control, under otherwise corresponding conditions, the actual consumption of each of these articles of plant food. Our information regarding these points is still too fragmentary to enable a more detailed statement

here beyond relative proportions. It must suffice for the present to call attention to the fact that a liberal manuring within reasonable limits pays, as a rule, better than a scanty one, especially in the case of those crops which reach in a short period the desired state of maturity. The various mixtures of fertilizers used by me in the experiments under discussion provide by actual supply for one-half of the available nitrogen actually called for to meet the demand as above pointed out. A liberal cultivation of peas and beans cannot fail to benefit the nitrogen resources of the soil. The order of arrangement of the different crops within each plat was the same in all of them for the same year. They occupied, however, a different position relative to each other in successive years, to introduce, as far as practicable, a system of rotation of crops.

Order of arrangement of crops in plats: —

Celery.
Lettuce.
Spinach.
Beets.
Cabbages.
Tomatoes.
Potatoes.

Spinach.
Celery.
Lettuce.
Red Cabbage.
Beets.
Potatoes.
Beets.
White Cabbage.
Tomatoes.

Potatoes.
Beans.
Tomatoes.
Spinach.
Lettuce.
Onions.

Onions.
Corn.
Beans.
Tomatoes.

The results of the stated three years were summed up as follows in my annual report for 1894, to which I have to refer for details. From our observations extending over three years we arrived at the following conclusions: —

Potash in the form of sulphate has given the most satisfactory results, as compared with muriate, in the case of potatoes, tomatoes, lettuce and spinach, and with onions during the present season.

Nitrogen in the form of nitrate of soda has given us, without regard to the potash source, the most satisfactory returns in case of spinach, lettuce, potatoes and tomatoes, and onions during the present season.

1895. — During the last season my observations have been confined to the cultivation of

Onions (Danvers Yellow).
Sweet Corn (Crosby Early).
Beans (Bush Horticultural).
Tomatoes (Essex Hybrid).

The different plats were ploughed April 20, and the particular fertilizer applied broadcast April 25. The soil was subsequently carefully prepared by harrowing, etc., for seeding and planting. The tomato plants were raised under glass and transplanted into the field when of a suitable size, May 25. The remaining crops were seeded directly in the field, — the onions May 1, the corn and the beans May 11.

The former division of the field into six plats, each containing the same crop for trial, — onions, beans, sweet corn and tomatoes, — was continued; each plat received the same mixture of fertilizing ingredients, and in the same proportion, as in the preceding years: —

	Pounds.
Available phosphoric acid,	50
Available nitrogen,	60
Available potassium oxide,	120

As each of the six plats measured $89\frac{1}{2}$ by 62 feet, covering thus an area of 5,549 square feet, or about 100 square feet more than one-eighth of one acre, the following amount of each of the above-stated essential constituents of plant food was added to each of them: —

	Pounds.
Phosphoric acid,	$7\frac{1}{2}$
Potassium oxide,	15
Nitrogen,	$6\frac{1}{4}$

The crops were planted across each plat, from north to south, in rows 62 feet in length; a corresponding number of rows of each crop was planted in each plat, and they were arranged in each case in the same order of succession, beginning on the west end: —

Onions (Danvers Yellow), eight rows.
Sweet corn (Crosby Early), four rows.
Beans (Bush Horticultural), nine rows.
Tomatoes (Essex Hybrid), two rows.

Onions.

The onions were sown in rows 14 inches apart May 1; they came up May 12. The young plants looked least satisfactory upon plats 1 and 4, and most promising upon plats 2 and 5, July 11. The crop was harvested on all plats October 5. Plats 2 and 5 yielded more than one-half of the entire marketable crop, while plats 1 and 5 yielded but one-fifteenth of it.

Yield of Onions (Pounds).

PLATS.	Marketable.	Small.	Scullions.	Total.
Plat 1,	None.	30	100	130
Plat 2,	630	165	10	805
Plat 3,	375	70	80	525
Plat 4,	125	180	65	370
Plat 5,	455	190	16	661
Plat 6,	390	52	90	532

Sweet Corn.

The corn was planted in rows 3 feet 3 inches apart, with 20 inches in the row, averaging 131 hills in each plat, May 11. The young plants came up May 27 quite uniformly on all plats.

July 11 the crop on Plat 1 looked lighter than on any of the rest. The canes were reduced to three in each hill before heading, and the tops removed after the ears were fully developed, to hasten on maturing of the crop. There is a marked difference in the results as far as Plat 1 is concerned, — organic nitrogen gives the highest results; in case of different forms of potash, Plat 3 and Plat 6.

Yield of Sweet Corn when husked (Pounds).

PLATS.	Ears.	Husks.	Stover with Tops.	Total Weight.
Plat 1,	98	10	95	203
Plat 2,	117	8	115	240
Plat 3,	125	11	137	273
Plat 4,	112	10	125	247
Plat 5,	103	8	112	223
Plat 6,	118	10	130	258

Moisture in ears 34 per cent., in stover 20 per cent., when weighed.

Beans.

The beans were planted in rows 3 feet 3 inches apart May 11. They came up May 29 and blossomed July 6. At that time the crop looked best on Plat 5. The beans were harvested on all plats August 13, stacked on poles for drying, and were threshed in October.

Yield of Beans (Pounds).

PLATS.	Beans.	Pods and Vines.	Total Weight.
Plat 1,	81	260	341
Plat 2,	105	200	305
Plat 3,	83	155	238
Plat 4,	115	210	325
Plat 5,	135	260	395
Plat 6,	95	175	270

Tomatoes (Essex Hybrid).

The tomato plants were started under glass and transplanted in the field when from seven to eight inches high, May 25. They were of a vigorous growth, and were placed four feet apart each way. Each plat was planted with two rows, each row containing twenty-one plants. They began blooming June 5, and looked healthy at that time in all plats, yet best in Plat 5. The yield of matured tomatoes in case of plats 4 and 5 exceeded that of plats 3 and 6 by fully one-third in weight. The total yield of the crop, on account of more favorable weather of the past season, as compared with that of 1894, exceeded the latter by more than one-half of its weight.

Yield of Tomatoes (Pounds).

[Forty-two plants in each plat.]

DATE OF PICKING.	Plat 1.	Plat 2.	Plat 3.	Plat 4.	Plat 5.	Plat 6.	Total.
August 13,	10	11	12	18	5	19	75
August 16,	85	79	125	87	57	134	567
August 20,	100	109	101	136	115	116	677
August 23,	115	134	90	150	143	86	718
August 28,	50	122	77	102	116	110	577
September 3,	151	153	133	215	210	124	986
September 11,	70	80	40	127	164	43	524
September 20,	138	40	-	63	96	-	337
September 25,	28	93	-	33	90	-	244

Yield of Green Tomatoes left October 1 (Pounds).

Plat 1,	30
Plat 2,	52
Plat 3,	26
Plat 4,	54
Plat 5,	48
Plat 6,	24
Total,	234

Summary of Yield of Garden Crops raised under Corresponding Conditions from 1891 to 1896.

Spinach (Variety New Zealand).

[Pounds.]

PLATS.	1892.	1893.	1894.	Total.	Average per Year.
Plat 1 (two rows, 62 feet long), .	192	167½	101	460	153.3
Plat 2 (two rows, 62 feet long), .	233	182	216	631	210.5
Plat 3 (two rows, 62 feet long), .	202	180½	165	547	182.3
Plat 4 (two rows, 62 feet long), .	230	196	161¾	587	195.7
Plat 5 (two rows, 62 feet long), .	232	210	253	695	231.7
Plat 6 (two rows, 62 feet long), .	134	198½	113¾	446	148.7

Lettuce (Variety Hanson).

[Pounds.]

PLATS.	1892.	1893.	1894.	Total.	Average per Year.
Plat 1 (one row, 70 plants), .	41½	40½	29	111	37.0
Plat 2 (one row, 70 plants), .	36	42	52	130	43.3
Plat 3 (one row, 70 plants), .	43	46	36	125	41.7
Plat 4 (one row, 70 plants), .	76	62	50	188	62.7
Plat 5 (one row, 70 plants), .	60	70	68	198	66.0
Plat 6 (one row, 70 plants), .	36	55	33	124	41.3

Tomatoes (Variety Essex Hybrid).

[Pounds.]

PLATS.	1892.	1893.	1894.	1895.	Total.	Average per Year.
Plat 1 (two rows, 42 plants),	464	363	352	747	1,926	481.5
Plat 2 (two rows, 42 plants),	572	874½	559	821	2,826	706.5
Plat 3 (two rows, 42 plants),	466	807	458	578	2,309	577.3
Plat 4 (two rows, 42 plants),	515	818	604	931	2,868	717.0
Plat 5 (two rows, 42 plants),	593	978½	594	996	3,161	790.2
Plat 6 (two rows, 42 plants),	332	515	571	632	2,050	502.5

Beans (Bush Horticultural).

[Pounds.]

PLATS.	1894.	1895.	Total.	Average per Year.
Plat 1 (six rows), ...	45	54.0	99.0	49.5
Plat 2 (six rows), ...	32	70.0	102.0	50.1
Plat 3 (six rows), ...	41	55.5	96.5	48.2
Plat 4 (six rows), ...	20	67.7	87.7	43.8
Plat 5 (six rows), ...	37	90.0	127.0	63.5
Plat 6 (six rows), ...	49	63.3	112.3	56.1

Onions (Danvers Yellow Globe).

[Pounds.]

PLATS.	1894.	1895.	Total.	Average per Year.
Plat 1 (four rows), ...	156	65.0	221.0	110.5
Plat 2 (four rows), ...	249	402.5	651.5	325.7
Plat 3 (four rows), ...	251	262.5	513.5	256.7
Plat 4 (four rows), ...	256	185.0	441.0	220.5
Plat 5 (four rows), ...	266	330.5	596.5	298.3
Plat 6 (four rows), ...	204	265.5	469.5	234.8

Conclusions.

1. Sulphate of potash in connection with nitrate of soda (Plat 5) has given in every case but one (onions) the best results.

2. Nitrate of soda as nitrogen source (plats 2 and 5) has yielded in every case, without reference to the form of potash, the best returns.

3. Sulphate of ammonia as nitrogen source, in connection with muriate of potash as potash source (Plat 1), has given as a rule the least satisfactory returns.

4. The influence of the difference in the general character of the weather, whether normal or dry, during succeeding seasons on the yield of the crops has been greater than that of the different fertilizers used upon different plats during the same season.

5. Field Experiments to study the Effect of Phosphatic Slag and Nitrate of Soda, as compared with Ground Bone, on the Yield of Oats and Corn.

The field used for this experiment is situated along a gently sloping ground, in the south-east corner of the farm. The soil consists of a sandy loam, and has been for several years under a careful system of cultivation and manuring. The productiveness was considered of uniform character when the experiment was planned in 1893. The area engaged in the observation was divided into two plats running along the slope from north to south. One plat, situated along the east side of the field, measured one acre (Plat 1); Plat 2 was situated along the west side of the field and measured one and nine-tenth acres.

Plat 1 was fertilized with 600 pounds of fine-ground bone and 200 pounds of muriate of potash per acre; Plat 2 was fertilized with 800 pounds of fine-ground phosphatic slag (odorless phosphate), 200 pounds of muriate of potash and 200 pounds of nitrate of soda per acre.

The amounts of manurial ingredients used per acre correspond to (in pounds): —

	Plat 1 (Bone).	Plat 2 (Phosphatic Slag).
Potassium oxide,	104	104
Phosphoric acid,	131	166
Nitrogen,	24	31

Composition of Fertilizer applied (Per Cent.).

	Nitrogen.	Phosphoric Acid.	Potassium Oxide.
Ground bone,	4.09	21.86	–
Phosphatic slag,	–	20.84	–
Muriate of potash,	–	–	52.20
Nitrate of soda,	15.70	–	–

Cost of Fertilizer (1894).

Plat 1, bone and muriate of potash (per acre), $12.40.
Plat 2, phosphatic slag, muriate of potash and nitrate of soda (per acre), $15.70.

1894. — As the east side of the field was on a higher level than the west side, it was decided to run the crop across the two plats from east to west, to secure as far as practicable corresponding conditions of the layout of the area occupied by the crops. The northern half of the field thus divided (plats 1 and 2) measured one acre, the southern half one and nine-tenths acres.

Oats and corn (variety Pride of the North) were selected for our observations. The oats were sown broadcast, at the rate of 4 bushels per acre, upon the northern portion of the field, and the corn was planted in rows 3 feet 3 inches apart, with hills 20 inches from each other, upon the southern portion, using 12 quarts of seed corn per acre. The area occupied by oats amounted to .35 of an acre of Plat 1 and .65 of an acre of Plat 2; while the corn occupied .7 of an acre of Plat 1 and 1.2 acres of Plat 2.

Summary of Yield (1894).

[Pounds per Acre.]

	Plat 1 (Bone, etc.).	Plat 2 (Odorless Phosphate, etc.).
Oats, grain,	531	876
Oats, straw,	1,640	2,385
Corn, for ensilage,	16,294	20,608

To test the reliability of the results obtained, it was decided to repeat the experiments above described upon the same field. The fertilizers were used in the same proportion and in the same quantity per acre; they were applied upon the same portion of the field which had received each kind before. Oats and corn were again selected as crops for the trial. The material change in the experiment consisted in reversing the location of the crops; the corn was planted at

the north end of the field, where the oats had been raised during the preceding season, and the oats were raised at the south end of the field, the part previously occupied by the corn. The oats were cut for hay when well headed out, and the corn when fully matured, for grain and stover.

Summary of Yield (1895).

[Pounds per Acre.]

	Bone and Muriate of Potash.	Phosphatic Slag, Nitrate of Soda, Muriate of Potash.
Oats, hay,	3,580	5,134
Corn, ears,*	3,410	4,231
Corn, stover †	2,900	3,091

* Moisture, 28 per cent. † Moisture, 19.1 per cent. when harvested.

Conclusions.

The difference in the yield of oats and corn for two succeeding seasons points in the same direction; namely, phosphatic slag used in connection with nitrate of soda is a very efficient substitute for ground bone. To what extent these results, in our case, have to be ascribed to the presence of an excess of lime in the phosphatic slag, as compared with ground bone, is to be determined by a future actual trial.

6. Experiments with a Rotation of Manures upon Permanent Grass Lands, Meadows and Pastures.

One of the many advantages derived from the introduction of commercial fertilizers and chemicals for manurial purposes into general farm practice consists in the circumstance that in many instances a change with reference to the general character of the manure applied has served efficaciously as a substitute for a change of crops. The improved chances in compounding the manures to suit special requirements of soil and crops have, to say the least, greatly modified current views regarding the desirability or necessity of a rotation of crops in the interest of economy. The beneficial results noticed in other connections, due to a change in the general character of the manurial substances used, in case of the same land and in connection with the same crops, caused the arrangement of the experiments described upon a few subsequent pages.

Permanent grass lands are apt to suffer in the course of time from an accumulation of half-decayed vegetable matter, which is liable sooner or later to interfere with a healthy growth. To counteract this tendency it was decided to manure meadows alternately by top-dressing with barn-yard manure, or bone and muriate of potash, or wood ashes. The liberal amount of carbonate of lime, from 30 to 40 per cent., contained in the current supply of unleached wood ashes, was to serve as the means to hasten on the decomposition of the accumulating vegetable matter, and thereby secure favorable conditions for a healthy growth of valuable forage plants.

The meadows under consideration comprise an area of about 9.6 acres. The entire field up to 1886 consisted of old, worn-out grass lands, overrun with a worthless growth on its more elevated portion and covered with weeds and sedges in its lower swampy portion. The improvement of the land by underdraining was commenced in 1886 and continued during the succeeding year. For details of the work, see ninth and tenth annual reports (1891–92).

In the spring of 1893 a change was made in the mode of manuring of the grass plats. It was decided to study the

effect of a rotation of the three kinds of manures: barn-yard manure, bone and muriate of potash and Canada wood ashes, which had been applied for several years previous in succession and upon the same portion of the fields. The area was divided into three plats, Plat 1 (3.97 acres), Plat 2 (2.59 acres) and Plat 3 (3 acres). The system of manuring adopted was as follows: —

Plat 1, wood ashes, 1 ton per acre.

Plat 2, barn-yard manure, 8 tons per acre.

Plat 3, fine-ground bone 600 pounds, and muriate of potash 200 pounds, per acre.

The barn-yard manure was applied broadcast late in autumn, the others early in the spring.

1895. — The above arrangement of plats was continued during that season, and fertilizers were applied in the same proportion to the same plats.

Summary of Yield of Hay (Tons).

	Rate per Acre (Tons).		
	First Cut.	Second Cut, "Rowen."	Total.
1893.			
Plat 1, wood ashes, 1 ton per acre,	2.28	.77	3.05
Plat 2, barn-yard manure, 8 tons per acre,	2.62	.86	3.48
Plat 3, 600 pounds ground bone and 200 pounds muriate of potash per acre,	1.94	.64	2.58
1894.			
Plat 1, wood ashes, 1 ton per acre,	2.50	.37	2.87
Plat 2, barn-yard manure, 8 tons per acre,	2.86	.51	3.37
Plat 3, 600 pounds ground bone and 200 pounds muriate of potash per acre,	2.54	.18	2.72
1895.			
Plat 1, 600 pounds ground bone and 200 pounds muriate of potash per acre,	2.18	1.60	3.14
Plat 2, wood ashes, 1 ton per acre,	2.17	1.44	3.12
Plat 3, barn-yard manure, 8 tons per acre,	3.02	1.04	3.13

The season of 1894 was marked by a severe drought, beginning with the month of July and extending into the fall, which affected the yield of the crop (second cut) to a serious extent. The season of 1895 was a fair one for farm work in our section of the country.

Part II.

REPORT ON THE WORK IN THE CHEMICAL LABORATORY.

CHARLES A. GOESSMANN.

1. On Official Inspection of Commercial Fertilizers in 1895.

During the past year fifty-five manufacturers and dealers in commercial fertilizers and agricultural chemicals have applied for and secured licenses for the sale of their goods in the State; twenty-seven of them being residents of Massachusetts, and the remainder belonging to Vermont, Rhode Island, Connecticut, New York, New Jersey, Maryland, Pennsylvania, Illinois, Ohio and Canada.

The number of different brands collected in the general market amounted to two hundred and ninety. The sampling and collecting of the material for analysis were in charge of Mr. H. D. Haskins, an efficient assistant in the chemical laboratory of the division of chemistry of the station, who for several years past has attended to that part of the inspection in a very satisfactory manner. Two hundred and seventy samples of the various brands collected by him were carefully analyzed, and the results obtained in that direction have been published and distributed in five special bulletins, *i. e.*, No. 57 old series and Nos. 30, 31, 32 and 34 of the Hatch station series.

The results of the inspection have been on the whole quite satisfactory, as far as the compliance of the dealers with the provision of our State laws for the regulation of the trade in commercial fertilizers is concerned. The variations here and there noticed between the guaranteed composition of the dealer and the results of our analyses could be traced with

but few exceptions to imperfect mixing of the several ingredients of the fertilizer, and did not, as a rule, materially affect the commercial value of the article. In this connection attention should be called to the fact that the lowest amount stated in the guarantee is only legally binding. As our State law makes allowance for these circumstances, the results of our examinations have been published without further comment. When deemed best for the interest of all parties concerned, the results have been sent by letter to the manufacturers of the goods, for their guidance and consideration. To convey a more direct idea of the actual value of this feature in the trade of commercial fertilizers of 1895, the following detailed statement is here inserted : —

(*a*) Where three essential elements of plant food were guaranteed : —

Number with three elements equal to or above the highest guarantee,	5
Number with two elements above the highest guarantee,	11
Number with one element above the highest guarantee,	49
Number with three elements between the lowest and highest guarantees,	45
Number with two elements between the lowest and highest guarantees,	54
Number with one element between the lowest and highest guarantees,	27
Number with two elements below the lowest guarantee,	6
Number with one element below the lowest guarantee,	30

(*b*) Where two essential elements of plant food were guaranteed : —

Number with two elements above the highest guarantee,	1
Number with one element above the highest guarantee,	11
Number with two elements between the lowest and highest guarantees,	17
Number with one element between the lowest and highest guarantees,	7
Number with one element below the lowest guarantee,	10

(*c*) Where one essential element of plant food was guaranteed : —

Number above the highest guarantee,	4
Number between the lowest and highest guarantees,	21
Number below the lowest guarantee,	6

The consumption of commercial fertilizers is steadily increasing, a circumstance apparently not less due to a more general recognition of their good services, if judiciously selected and applied, than to gradual improvements in regard to their mechanical condition as well as their general chemical character. A noticeable change regarding the chemical composition of many brands of so-called complete or formula fertilizers of to-day, as compared with those offered for similar purposes at an earlier period in the history of the trade in commercial fertilizers, consists in a more general and more liberal use of potash compounds as a prominent constituent. This change has been slow but decided, and may in a large degree be ascribed to the daily increasing evidence, resting on actual observations in the field and garden, that the farm lands of Massachusetts are quite frequently especially deficient in potash compounds, and consequently need in many instances a more liberal supply of available potash from outside sources to give satisfactory returns. Whenever the cultivation of garden vegetables, fruits and forage crops constitutes the principal products of the land, this recent change in the mode of manuring deserves in particular a serious trial; for the crops raised consume exceptionally large quantities of potash, as compared with grain crops. In view of these facts, it will be conceded that a system of manuring farm and garden, which tends to meet more satisfactory recognized conditions of large areas of land as well as the special wants of important growing branches of agricultural industries, is a movement in the right direction. A judicious management of the trade in commercial fertilizers implies a due recognition of well-established experimental results regarding the requirements of a remunerative production of farm and garden crops.

List of Manufacturers and Dealers who have secured Certificates for the Sale of Commercial Fertilizers in This State during the Past Year (May 1, 1895, to May 1, 1896), and the Brands licensed by Each.

Armour & Co., Chicago, Ill.: —
- Bone Meal.
- Bone and Blood.
- All Soluble.
- Bone, Blood and Potash.

H. J. Baker & Bro., New York, N. Y.: —
- Standard Unexcelled Fertilizer.
- Strawberry Manure.
- Complete Onion Manure.
- Complete Potato Manure.
- Complete Tobacco Manure.
- Complete Grass and Lawn Manure.
- Complete Corn Manure.
- A A Ammoniated Superphosphate.
- Strictly Pure Ground Bone.
- Vegetable and Vine Fertilizer.

C. A. Bartlett, Worcester, Mass.: —
- Complete Animal Fertilizer.
- Pure Ground Bone.

Bowker Fertilizer Company, Boston, Mass.: —
- Stockbridge Special Manures.
- Bowker's Hill and Drill Phosphate.
- Bowker's Farm and Garden Phosphate.
- Bowker's Lawn and Garden Dressing.
- Bowker's Fish and Potash.
- Bowker's Potato and Vegetable Manure.
- Bowker's Market-garden Manure.
- Bowker's Sure Crop Bone Phosphate.
- Bowker's Gloucester Fish and Potash.
- Bowker's Dry Ground Fish.
- Bowker's Fresh Ground Bone.
- Nitrate of Soda.
- Dried Blood.
- Dissolved Bone-black.
- Muriate of Potash.
- Sulphate of Potash.
- Sulphate of Ammonia.

Bradley Fertilizer Company, Boston, Mass.: —
- Bradley's X L Superphosphate.
- Bradley's Potato Manure.
- Bradley's B D Sea-fowl Guano.
- Bradley's Complete Manures.
- Bradley's Fish and Potash.
- Bradley's High-grade Tobacco Manure.
- Bradley's English Lawn Dressing.
- Farmers' New-method Fertilizer.
- Breck's Lawn and Garden Dressing.
- Eclipse Phosphate.
- Dry Ground Fish.
- High-grade Sulphate of Potash.
- Low-grade Sulphate of Potash.
- Muriate of Potash.
- Nitrate of Soda.
- Sulphate of Ammonia.
- Dissolved Bone-black.
- Fine-ground Bone.

Wm. J. Brightman & Co., Tiverton, R. I.: —
- High-grade Potato and Root Manure.
- Brightman's Phosphate.
- Brightman's Fish and Potash.

Bryant, Brett & Simpson, New Bedford, Mass.: —
- Ground Bone.

B. L. Bragg & Co., Springfield, Mass.: —
- Hampden Lawn Dressing.

Dan. T. Church, Providence, R. I.: —
- Church's B Special Fertilizer.
- Church's D Fish and Potash.
- Church's C Standard.

Clark's Cove Fertilizer Company, Boston, Mass.: —
- Bay State Fertilizer.
- Bay State Potato Manure.
- Great Planet Manure.
- Fish and Potash.
- King Philip Guano.
- White Oak Pure Ground Bone.

Clark's Cove Fertilizer Company, Boston, Mass. — *Concluded.*
- Bay State Fertilizer, G G Brand.
- Potato and Tobacco Fertilizer.
- Tobacco Fertilizer.
- Blood, Bone and Meat.
- Dissolved Bone-black.
- Double Manure Salts.
- Sulphate of Potash.
- Muriate of Potash.
- Nitrate of Soda.

Cleveland Dryer Company, Boston, Mass. : —
- Cleveland Superphosphate.
- Potato Phosphate.
- Corn and Grain Phosphate.
- Fertilizer.
- High-grade Complete Manure.

E. Frank Coe Company, New York, N. Y. : —
- Gold Brand Excelsior Guano.
- High-grade Ammoniated Bone Superphosphate.
- Special Potato Fertilizer.
- Fish and Potash.
- High-grade Potato Fertilizer.

Crocker Fertilizer and Chemical Company, Buffalo, N. Y. : —
- Special Potato Fertilizer.
- Ammoniated Bone Superphosphate.
- Ammoniated Wheat and Corn Phosphate.
- New Rival Ammoniated Superphosphate.
- Potato Hop and Tobacco Phosphate.
- Ground Bone Meal.
- Practical Ammoniated Superphosphate.
- Pure Ground Bone.
- Vegetable Bone Superphosphate.

Cumberland Bone Phosphate Company, Boston, Mass. : —
- Superphosphate.
- Potato Fertilizer.
- Fertilizer.
- Concentrated Phosphate.
- Fine-ground Bone.

L. B. Darling Fertilizer Company, Pawtucket, R. I. : —
Animal Fertilizer.
Extra Bone Phosphate.
Potato and Root Fertilizer.
Lawn and Garden Manure.
Tobacco Grower.
Pure Fine Bone.
Pure Dissolved Bone.
High-grade Sulphate of Potash.

John C. Dow & Co., Boston, Mass. : —
Dow's Ground Bone Fertilizer.
Dow's Nitrogenous Superphosphate.
Dow's Pure Ground Bone.

Eastern Farm Supply Association, Montclair, N. J. : —
Carteret Farm Manure.
Carteret Potato Manure.
Carteret Corn and Grain Manure.
Carteret Market-garden Manure.

Forest City Wood Ash Company, Boston, Mass. : —
Unleached Hard-wood Ashes.
Odorless Mineral Guano.

Wm. E. Fyfe & Co., Clinton, Mass. : —
Canada Ashes.

Great Eastern Fertilizer Company, Rutland, Vt. : —
Great Eastern Soluble Bone and Potash.
Great Eastern Grain and Grass.
Great Eastern Oats, Buckwheat and Seeding-down.
Great Eastern Vegetable Vine and Tobacco.

Edmund Hersey, Hingham, Mass. : —
Ground Bone.

John G. Jefferds, Worcester, Mass. : —
Animal Fertilizer.
Potato Fertilizer.
Ground Bone.

A. Lee & Co., Lawrence, Mass. : —
Lawrence Fertilizer.

Lowe Bros. & Co., Fitchburg, Mass. : —
Tankage.

Lowell Rendering Company, Chelmsford, Mass. : —
Lowell Bone Fertilizer.

The Mapes Formula and Peruvian Guano Company, New York, N. Y. : —
Mapes' Bone Manures.
Mapes' Superphosphates.
Mapes' Special Crop Manures.
Mapes' Peruvian Guano.
Mapes' Economical Manure.
Sulphate of Potash.
Double Manure Salts.
Nitrate of Soda.

Mason, Chapin & Co., Providence, R. I. : —
Chemical Compound Corn Fertilizer.
Chemical Compound Lawn Fertilizer.
Chemical Compound Vegetable Fertilizer.
Chemical Compound Tobacco Fertilizer.
Lawn and Grass Fertilizer.

McQuade Bros., Worcester, Mass. : —
Pure Ground Bone.

Monroe, Lalor & Co., Oswego, N. Y. : —
Canada Unleached Hard-wood Ashes.

Robert L. Merwin & Co., New York, N. Y. : —
Albert's Highly Concentrated Horticultural Manure.

National Fertilizer Company, Bridgeport, Conn. : —
Ammoniated Bone Phosphate.
Chittenden's Complete Fertilizer.
Fish and Potash.
Ground Bone.

New England Dressed Meat and Wool Company, Boston, Mass. : —
Sheep Fertilizer.

Niagara Fertilizer Company, Buffalo, N. Y. : —
Niagara Triumph.
Niagara Grain and Grass Grower.
Niagara Wheat and Corn Producer.
Niagara Potato, Tobacco and Hop Fertilizer.

Pacific Guano Company, Boston, Mass. : —
- Soluble Pacific Guano.
- Special Potato Fertilizer.
- Special for Potatoes and Tobacco.
- High-grade General Fertilizer.
- Fish and Potash.
- Muriate of Potash.
- Dissolved Bone-black.
- Nitrate of Soda.
- Sulphate of Potash.

John J. Peters & Co., Long Island City, N. Y. : —
- Sheep Fertilizer.

Parmenter & Polsey Fertilizer Company, Peabody, Mass. : —
- Plymouth Rock Brand.
- Special Potato Fertilizer.
- Star Brand Superphosphate.
- Ground Bone.
- Muriate of Potash.
- Nitrate of Soda.

Prentiss Brooks & Co., Holyoke, Mass. : —
- Complete Manures.
- Phosphate.
- Nitrate of Soda.
- Tankage.
- Dissolved Bone-black.
- Muriate of Potash.
- Sulphate of Potash.
- Fish and Potash.
- Fish.

Quinnipiac Company, Boston, Mass. : —
- Phosphate.
- Potato Manure.
- Onion Manure.
- Havana Tobacco Fertilizer.
- Corn Fertilizer.
- Market-garden Manure.
- Potato and Tobacco Manure.
- Fish and Potash, "Crossed Fishes."
- Fish and Potash, "Plain Brand."
- Grass Fertilizer.

Quinnipiac Company, Boston, Mass. — *Concluded.*
- Pure Bone Meal.
- Dry Ground Fish.
- Strawberry Manure.
- Ammoniated Dissolved Bones.
- Nitrate of Soda.
- Sulphate of Potash.
- Muriate of Potash.
- Double Manure Salts.

Read Fertilizer Company, New York, N. Y.: —
- Read's Standard.
- High-grade Farmers' Friend.
- Fish and Potash.
- Vegetable and Vine.

N. Roy & Son, South Attleborough, Mass.: —
- Animal Fertilizer.

The Rogers & Hubbard Company, Middletown, Conn.: —
- Pure Ground Raw Knuckle Bone Meal.
- Strictly Pure Fine Bone.
- Fertilizer for Oats and Top-dressing.
- Soluble Potato Manure.
- Fairchild's Formula for Corn and General Crops.
- Soluble Tobacco Manure.
- Grass and Grain Fertilizer.

Russia Cement Company, Gloucester, Mass.: —
- Essex Complete Manure for Potatoes and Roots.
- Essex Complete Manure for Corn and Grain.
- Essex Perfected Lawn Dressing.
- Essex Special Vegetable Manure.
- Essex High-grade Fish and Potash.

Lucien Sanderson, New Haven, Conn.: —
- Formula "A."
- Bone, Meat and Blood.
- Dissolved Bone-black.
- Sulphate of Potash.
- Muriate of Potash.
- Nitrate of Soda.

Edward H. Smith, Northborough, Mass.: —
- Ground Bone.

Springfield Provision Company, Brightwood, Mass.: —
Blood, Meat and Bone.

Standard Fertilizer Company, Boston, Mass.: —
Complete Manure.
Potato and Tobacco Manure.
Fertilizer.
Guano.
Fish and Potash.
Fine-ground Bone.
Muriate of Potash.
Dissolved Bone-black.

T. L. Stetson, Randolph, Mass.: —
Pure Ground Bone.

F. C. Sturtevant, Hartford, Conn.: —
Ground Tobacco Stems.

Charles Stevens, Napanae, Ontario, Can.: —
Unleached Hard-wood Ashes.

Henry F. Tucker, Boston, Mass.: —
Tucker's Original Bay State Bone Superphosphate.
Tucker's Imperial Bone Superphosphate.
Tucker's Special Potato Fertilizer.

Thompson & Edwards Fertilizer Company, Chicago, Ill.: —
Pure Fine-ground Bone.

Walker, Stratman & Co., Pittsburg, Pa.: —
Potato Special.
Smoky City.
Big Bonanza.
Four Fold.

M. E. Wheeler & Co., Rutland, Vt.: —
High-grade Fruit Fertilizer.
Grass and Oats Fertilizer.
Electrical Dissolved Bone.
Potato Manure.
High-grade Corn Fertilizer.

Leander Wilcox, Mystic, Conn.: —
Potato, Onion and Tobacco Manure.
Ammoniated Bone Phosphate.
Fish and Potash.
Dry Ground Fish.

Williams & Clark Fertilizer Company, Boston, Mass.: —
Americus Ammoniated Bone Superphosphate.
Potato Phosphate.
Grass Manure.
Pure Bone Meal.
High-grade Special.
Corn Phosphate.
Fine Wrapper Tobacco Fertilizer.
Universal Ammoniated Dissolved Bone.
Fish and Potash.
Dry Ground Fish.
Potato and Tobacco Manure.
Royal Bone Phosphate.
Onion Manure.
Dissolved Bone-black.
Nitrate of Soda.
Double Manure Salts.
Sulphate of Potash.
Muriate of Potash.

2. General Work in the Laboratory of the Division of Chemistry.

The work in the chemical laboratory of the united stations has been divided by a recent vote of the board of trustees between the newly created division of "Foods and Feeding" and the "Division of Chemistry." The separate operation of the two divisions dates from July 1, 1895. The analyses of feeds stuffs, dairy products and well waters made before that date are incorporated in the annual report of Dr. J. B. Lindsey, who by vote of the trustees has been placed in charge of the new division of foods and feeding, which includes in its scope the examination of these substances.

Aside from the supervision of the inspection of commercial fertilizers, the results of which are discussed in a few preceding pages, my attention has been divided between the direction of a series of experiments in the field and vegetation house, introduced some years ago for the purpose of studying the economy of various systems of manuring and raising field and garden crops, and an extensive correspondence with farmers and others, asking for information regarding a variety of subjects of interest to them. The description of the former constitutes the first part of this report. The results of the examination of many manurial substances sent on for that purpose in connection with the latter, whenever of general interest, have been published during the past year in the bulletins of the station. They are also recorded in connection with the tabular compilation of analyses of manurial substances which accompanies this report.

The constantly increasing variety of waste products of many branches of industry within our State and elsewhere which have proved of manurial value, has received for years a serious attention. Both producers and consumers have been materially benefited by this work, which aims to make known the particular fitness of each for manurial purposes, and thereby furnishes a basis for the determination of its commercial value. As a change in the current modes of manufacture of the parent industry is at any time liable to

seriously affect the character and chemical composition of the waste or by-products, it becomes necessary to repeat from time to time analyses of many of these products. These analyses are made without any charge for the work, on the condition that the results are public property, if deemed of interest for publication.

As a brief enumeration of the more prominent substances sent on for our investigation during the year 1895 can best convey a correct idea concerning the extent and importance of the labor involved, the following statement is presented: the whole number of analyses made in the stated connection amounts for the year 1895 to one hundred and eighty-six; of these, from eighty to ninety consisted of ashes, including wood ashes, coal ashes, lime-kiln ashes, cotton-hull ashes, swill ashes, soots, etc.; from twenty to thirty were agricultural chemicals, comprising potash salts, Chili saltpetre, sulphate of ammonium, gypsum, kainites, dissolved bone-black, phosphatic slag, etc.; twenty-eight were animal refuse materials, as fish waste, tankage, blood, animal meal, meat scraps, blood and bone, bones, wool waste, sheep fertilizer, etc.; and from twenty to thirty consisted of vegetable refuse materials, as cotton-factory waste, cotton-seed meal, tobacco stems, madder, peats, vegetable compost, etc.

Of a special interest is the recent introduction of the products prepared from the kitchen refuse of our large cities. Sanitary considerations are indirectly the cause of the appearance of these products, which promise to become of considerable prominence in the future.

One mode disposes of the refuse by cremation. The product resulting is called cremation ashes, and contains a liberal amount of phosphate of lime and more or less potash. The nitrogen and organic matter are lost in the process of cremation. Grinding and proper mixing of the products cannot fail to furnish a valuable material for manurial purposes. The tabular statement below gives the results of analyses of swill or cremation ashes, mostly if not entirely from Lowell, Mass.

Another mode proposes to save the nitrogen and organic matter by a so-called reduction process. The parties in-

terested in the matter propose to reduce the garbage with sulphuric acid, remove the fat, add to the refuse natural phosphates to combine with the excess of sulphuric acid, and add potash compounds if needed. This interesting process is apparently still in the experimental stage. A sample of the product sent here for examination gives the results found below. Modern views regarding the requirements of sanitary condition in our centres of population cannot fail to recognize the efficiency of both processes to dispose of objectionable material. The economical advantages derived from these modes of operation experience alone can determine. The product of either mode has its special claim for consideration. The agricultural interests of the country cannot fail to benefit by a successful development of either mode of operation.

Analyses of Ashes from a Crematory Furnace, Lowell, Mass.

	1.	2.	3.	4.	5.	6.	7.
Moisture at 100° C.,	0.51	0.07	0.04	0.11	2.43	19.46	12.48
Potassium oxide,	1.73	8.83	7.03	1.25	1.59	1.78	3.35
Phosphoric acid,	16.61	17.18	26.09	32.23	25.89	5.22	6.50
Calcium oxide,	24.79	28.18	33.74	47.60	-*	-*	-*
Ferric and aluminic oxides,	3.56	7.63	6.25	1.06	-*	-*	-*
Magnesium oxide,	1.87	-*	-*	-*	-*	-*	-*
Insoluble matter before calcination,	39.60	18.49	14.40	15.13	-*	-*	-*
Insoluble matter after calcination,	29.72	16.53	11.41	13.20	17.93	30.81	31.54

	8.	9.	10.	11.	12.	13.	14.
Moisture at 100° C.,	0.37	7.57	14.24	8.05	1.20	1.19	0.87
Potassium oxide,	4.27	3.96	5.09	4.92	5.71	4.83	4.08
Phosphoric acid,	12.97	13.92	6.86	13.22	10.82	10.21	71.47
Insoluble matter after calcination,	34.91	19.96	37.76	24.52	29.91	24.50	26.73

* Not determined.

Analysis of a Refuse Product obtained from City Garbage, sent on by the American Reduction Company, New York City.

	Per Cent.
Moisture at 100° C.,	8.52
Nitrogen,	1.64
Potassium oxide,	1.20
Sodium oxide,	2.50
Calcium oxide,	3.86
Magnesium oxide,	.55
Ferric and aluminic oxides,	7.64
Total phosphoric acid,	10.62
Available phosphoric acid,	8.08
Insoluble phosphoric acid,	2.54
Sulphuric acid,	8.54
Organic matter,	45.43
Insoluble matter (ash),	12.15

3. Compilation of Analyses made at Amherst, Mass., of Agricultural Chemicals and Refuse Materials used for Fertilizing Purposes.

Prepared by H. D. Haskins.

[As the basis of valuation changes from year to year, no valuation is stated.]

1868 to 1896.

This compilation does not include the analyses made of licensed fertilizers. They are to be found in the reports of the State Inspector of Fertilizers from 1873 to 1896, contained in the reports of the Secretary of the Massachusetts State Board of Agriculture for those years. C. A. G.

	Analyses.	Moisture.	Ash.	Nitrogen.			Potash.			Total Phosphoric Acid.			Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
				Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.											
I. Chemicals, Refuse, Salts, Ashes, etc.																							
Muriate of potash,	79	1.80	-	-	-	-	58.98	45.94	51.02	-	-	-	-	-	-	6.69	-	.55	-	-	-	48.80	.70
Sulphate of potash,	32	2.12	-	-	-	-	51.30	21.36	38.67	-	-	-	-	-	-	4.46	-	1.50	-	45.72	-	-	.75
Sulphate of potash-magnesia,	26	4.85	-	-	-	-	29.48	16.96	24.82	-	-	-	-	-	-	6.25	2.57	-	-	44.25	-	2.60	1.41
Carbonate of potash,	1	26.88	-	-	-	-	-	-	18.48	-	-	-	-	-	-	-	-	19.52	-	-	-	-	.39
Phosphate of potash,	1	3.76	-	-	-	-	-	-	32.56	-	-	37.50	-	-	-	-	-	-	-	13.43	-	-	.92
Kainite,	5	3.18	-	-	-	-	16.48	12.51	13.56	-	-	-	-	-	-	18.97	1.15	9.80	-	20.25	-	33.25	2.13
Carnallite,	1	-	-	-	-	-	-	-	13.68	-	-	-	-	-	-	7.66	-	13.19	-	.56	-	41.56	-
Krugite,	1	4.82	-	-	-	-	-	-	8.42	-	-	-	-	-	-	5.27	12.45	8.79	-	31.94	-	6.63	14.96
Sulphate of magnesia (Kieserite),	9	22.70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.82	17.30	-	36.10	-	-	5.73
Nitrate of potash,	4	1.30	-	14.58	11.60	12.71	45.62	44.76	45.27	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrate of soda,	36	1.42	-	16.22	14.28	15.02	-	-	-	-	-	-	-	-	-	35.50	-	-	-	-	-	.50	.50
Sulphate of ammonia,	28	1.06	-	21.68	19.59	22.03	-	-	-	-	-	-	-	-	-	-	-	-	-	60.00	-	-	-
Phosphate of ammonia,	1	6.05	-	-	-	10.37	-	-	-	-	-	43.86	-	-	-	-	-	-	-	12.46	-	-	.82
Sulphate of soda,	1	1.38	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	59.43	-	-	-
Saltpetre waste,	12	2.54	-	3.30	.52	2.22	30.94	1.55	13.66	-	-	-	-	-	-	37.04	.75	.19	-	1.85	-	46.25	-

Nitre salt-cake,	2	6.03	-	-	-	2.29	-	-	.87	-	-	-	-	-	-	29.56	-	-	-	47.77	-	-	3.92
Wood ashes,	476	10.64	-	-	-	-	10.80	1.20	5.37	5.58	.05	1.52	-	-	-	-	33.58	3.31	.96	-	-	-	14.22
Cotton-seed-hull ashes,	49	8.21	-	-	-	-	42.12	9.91	22.77	13.67	2.89	8.15	-	-	-	-	9.30	10.47	1.76	-	-	-	13.44
Ashes of spent tan-bark,	5	4.84	-	-	-	-	2.87	.60	1.81	2.77	.13	1.36	-	-	-	-	31.11	3.39	1.78	-	-	-	25.21
Corn-cob ashes,	1	1.20	-	-	-	-	-	-	7.08	-	-	2.37	-	-	-	-	11.70	-	1.28	-	-	-	52.09
Railroad-tie ashes,	1	4.70	-	-	-	-	-	-	.92	-	-	.56	-	-	-	-	2.51	-	-	-	-	-	80.20
Peat ashes,	1	4.67	-	-	-	-	-	-	.46	-	-	.11	-	-	-	-	2.28	1.63	6.13	-	-	-	45.17
Logwood ashes,	1	1.50	-	-	-	-	-	-	.08	-	-	2.30	-	-	-	-	3.90	-	-	-	-	-	9.70
Hard-pine wood ashes,	1	.75	-	-	-	-	-	-	10.16	-	-	2.24	-	-	-	-	24.95	-	-	-	-	-	29.90
Mill ashes,	1	.53	-	-	-	-	-	-	1.60	-	-	.46	-	-	-	-	34.93	1.35	-	-	-	-	36.36
Ashes from cremation of swill,	14	4.89	-	-	-	-	8.83	1.25	4.17	32.36	7.47	14.66	-	-	-	-	33.58	1.87	4.65	-	-	-	19.73
Ashes from blue works,	1	12.14	63.78	-	-	-	-	-	9.02	-	-	-	-	-	-	-	-	-	-	-	-	-	12.30
Sea-weed ashes,	1	1.47	-	-	-	-	-	-	.92	-	-	.30	-	-	-	8.76	6.06	4.37	-	2.98	-	6.60	63.65
Gypse,	1	1.64	-	-	-	-	-	-	-	-	-	-	-	-	-	-	50.87	-	-	-	-	-	2.87
Nova Scotia plaster (gypsum),	15	8.63	-	-	-	-	-	-	-	-	-	-	-	-	-	-	32.85	.75	-	45.12	-	-	3.47
Onondaga plaster (New York gypsum),	4	13.27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	30.00	4.66	-	32.50	8.20	-	9.83
Lime,	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	93.63	-	-	-	-	-	1.33
Waste lime,	1	.80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	74.12	-	-	-	-	-	.38
Gas-house lime,	3	22.28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	43.66	8.30	-	20.73	-	-	6.05
Lime waste from sugar factory,	1	36.30	-	-	-	-	-	-	.22	-	-	2.25	-	-	-	-	27.51	-	-	-	-	-	.32
Lime-kiln ashes,	17	14.48	-	-	-	-	2.78	.02	1.28	3.16	.36	1.09	-	-	-	-	42.57	2.60	-	-	17.75	-	7.69
Bituminous coal ashes,	1	7.18	-	-	-	-	-	-	.60	-	-	.43	-	-	-	-	-	-	-	-	-	-	68.50

	Analyses.	Moisture.	Ash.	Nitrogen. Maximum.	Nitrogen. Minimum.	Nitrogen. Average.	Potash. Maximum.	Potash. Minimum.	Potash. Average.	Total Phosphoric Acid. Maximum.	Total Phosphoric Acid. Minimum.	Total Phosphoric Acid. Average.	Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
I. Chemicals, Refuse, Salts, Ashes, etc. —Concluded.																							
Marls (Massachusetts), ...	7	13.70	-	-	-	-	-	-	.24	2.72	.06	1.05	-	-	-	-	40.50	.64	.69	-	28.57	-	3.44
Marls (Virginia), ...	2	15.98	-	-	-	-	.61	.37	.49	.09	.08	.09	-	-	-	-	7.25	.21	-	.66	7.25	-	64.23
Green sand marl (Virginia), . . .	1	1.25	-	-	-	-	-	-	1.14	-	-	9.37	-	-	-	-	25.78	-	5.13	-	-	-	41.32
Olive earth (Virginia), ...	1	1.97	-	-	-	-	-	-	.24	-	-	13.73	-	-	-	-	19.16	-	6.00	-	-	-	50.55
Ammoniated marl, ...	1	3.31	-	-	-	1.61	-	-	-	-	-	10.39	-	.41	9.98	-	-	-	-	-	-	-	-
Marl (North Carolina), ...	1	1.50	-	-	-	-	-	-	.04	-	-	.56	-	-	-	-	21.95	.61	-	-	-	-	50.18
Clay (so called), ...	1	.70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	54.35	1.04	2.80	-	37.32	-	2.57
II. Guanos, Phosphates, etc.																							
Peruvian guano, ...	26	14.81	37.61	13.50	4.44	7.85	4.08	1.14	2.61	20.60	5.96	15.26	4.57	3.79	6.90	-	-	-	-	-	-	-	6.60
Bat guano from Texas, ...	9	40.09	18.24	10.51	2.58	6.47	-	-	1.31	6.53	1.00	3.76	-	-	-	-	-	-	-	-	-	-	2.00
Bat guano from Florida, ...	2	15.66	-	-	-	9.74	-	-	1.77	3.44	3.26	3.35	-	-	-	-	-	-	-	-	-	-	19.33
Rat guano from Florida, ...	1	10.32	-	-	-	3.32	-	-	6.85	-	-	2.30	-	-	-	-	-	-	-	-	-	-	1.15
Cuban guano, ...	5	24.27	-	2.74	.63	1.67	-	-	-	16.16	11.54	13.35	-	-	-	-	-	-	-	-	-	-	3.17
Caribbean guano (orchilla), . . .	12	7.31	-	-	-	-	-	-	-	35.43	18.11	26.77	-	-	-	-	39.95	3.29	-	2.68	-	-	1.27
Mona Island guano, ...	1	13.32	-	-	-	.76	-	-	-	-	-	21.88	-	7.55	14.33	-	37.49	-	-	-	-	-	2.45

South Carolina rock phosphate,	6	1.45	-	-	-	-	-	-	-	30.51	24.70	27.47	.27	.07	27.13	-	41.87	3.03	4.80	-	-	-	9.04
South Carolina floats,	1	.83	-	-	-	-	-	-	-	-	-	23.39	-	2.33	21.06	-	-	-	-	-	-	-	20.16
Florida rock phosphate,	29	2.09	-	-	-	-	-	-	-	38.97	6.95	26.15	-	-	-	-	30.40	-	7.56	-	-	-	27.29
Soft Florida phosphate,	3	4.87	-	-	-	-	-	-	-	19.94	17.71	18.73	-	-	-	-	23.72	-	6.82	-	-	-	20.92
Navassa phosphate,	2	7.60	-	-	-	-	-	-	-	34.45	34.09	34.27	-	-	-	-	37.45	-	10.27	-	-	-	2.70
Brockville phosphate,	1	2.50	-	-	-	-	-	-	-	-	-	35.21	-	-	-	-	-	-	-	-	-	-	6.46
Phosphatic slag,	4	1.45	-	-	-	-	-	-	-	30.51	18.91	23.49	-	3.06	21.65	-	48.66	3.42	10.12	-	-	-	9.40
Odorless phosphate,	6	2.99	-	-	-	-	.52	.04	.38	21.74	18.40	19.54	-	.52	19.82	-	51.42	-	-	-	2.51	-	9.14
Dissolved bone-black,	6	10.31	47.50	-	-	-	-	-	-	17.54	14.99	16.00	14.48	1.15	.37	-	-	-	-	-	-	-	3.99
Bone-black,	5	4.60	-	-	-	-	-	-	-	30.54	16.56	28.28	-	-	-	-	-	-	-	-	-	-	3.64
Double superphosphate,	1	5.74	-	-	-	-	-	-	-	-	-	47.80	38.38	9.04	.38	-	16.00	-	-	1.19	-	-	.60
South American bone-ash,	1	7.00	-	-	-	-	-	-	-	-	-	35.89	-	-	-	-	44.89	-	-	-	-	-	4.50
Acid phosphate,	1	14.23	69.95	-	-	-	-	-	-	-	-	14.64	10.34	2.42	1.88	-	-	-	-	-	-	-	10.81
III. Refuse Substances.																							
Dried blood,	17	11.97	6.37	13.55	8.10	10.48	-	-	-	6.23	1.30	2.00	-	-	-	-	-	-	-	-	-	-	-
Ammonite,	1	5.88	-	-	-	11.33	-	-	-	-	-	3.43	-	-	-	-	-	-	-	-	-	-	1.38
Oleomargarine refuse,	1	8.54	14.42	-	-	12.12	-	-	-	-	-	.88	-	-	-	-	-	-	-	-	-	-	.96
Felt refuse,	1	29.24	33.53	-	-	5.26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sponge refuse,	1	7.25	-	-	-	2.43	-	-	-	-	-	3.19	-	-	-	-	3.94	1.27	-	-	-	-	39.05
Blood and bone,	2	8.36	-	6.80	6.68	6.74	-	-	-	11 39	10.62	11.01	-	2.82	7.80	-	-	-	-	-	-	-	-
Horn shavings,	1	4.83	-	-	-	15.31	-	-	-	-	-	.42	-	-	-	-	-	-	-	-	-	-	-

	Analyses.	Moisture.	Ash.	Nitrogen. Maximum.	Nitrogen. Minimum.	Nitrogen. Average.	Potash. Maximum.	Potash. Minimum.	Potash. Average.	Total Phosphoric Acid. Maximum.	Total Phosphoric Acid. Minimum.	Total Phosphoric Acid. Average.	Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
III. Refuse Substances — Continued.																							
Ivory dust,	1	11.50	52.63	-	-	6.64	-	-	-	-	-	24.56	.97	17.97	5.62	-	-	-	-	-	-	-	-
Horn and hoof waste,	3	10.17	7.63	15.49	11.84	13.25	-	-	-	2.30	1.36	1.83	-	-	-	-	-	-	-	-	-	-	.24
Raw wool,	1	6.95	7.54	-	-	12.88	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.63
Wool waste,	11	11.77	24.10	10.20	.96	4.56	3.50	.06	1.68	.67	.05	.31	-	-	-	-	.11	.06	.80	-	-	-	8.20
Wool washings (water),	1	-	-	-	-	-	-	-	3.92	-	-	-	-	-	-	.49	.28	-	-	-	-	-	-
Wool washings (acid),	1	-	-	-	-	-	-	-	4.20	-	-	-	-	-	-	.40	.61	.20	-	-	-	-	-
Wool washings (alkaline),	1	92.03	3.28	-	-	.09	-	-	1.09	-	-	-	-	-	-	.92	.04	-	-	-	-	-	.22
Morocco factory waste,	1	22.72	-	-	-	1.16	-	-	.36	-	-	2.56	-	-	-	-	19.60	-	-	1.24	-	-	24.17
Meat scrap,	2	24.79	-	-	-	6.33	-	-	-	-	-	5.79	-	-	-	-	-	-	-	-	-	-	-
Meat mass,	5	12.09	13.60	11.50	9.69	10.44	-	-	-	3.58	.56	2.07	-	-	-	-	-	-	-	-	-	-	.58
Bone soup,	1	82.92	7.07	-	-	1.14	-	-	-	-	-	1.26	-	-	-	-	-	-	-	-	-	-	-
Dried soup from meat and bone,	1	14.80	8.40	-	-	9.97	-	-	-	-	-	.53	-	-	-	-	-	-	-	-	-	-	.64
Dried soup from rendering cattle feet,	1	10.80	7.50	-	-	14.47	-	-	-	-	-	.46	-	-	-	-	-	-	-	-	-	-	.26
Dried soup from horse rendering,	1	92.14	-	-	-	1.12	-	-	-	-	-	.14	-	-	-	-	-	-	-	-	-	-	-
Soap-grease refuse,	2	29.25	51.39	4.20	2.21	3.21	-	-	-	15.37	11.04	13.21	-	-	-	-	-	-	-	-	-	-	1.29
Bones,	164	6.87	53.03	4.70	1.57	3.91	-	-	-	32.52	15.16	22.37	.38	8.22	13.74	-	-	-	-	-	-	-	1.08

Meat and bone,	2	5.26	-	-	-	4.57	-	-	-	-	-	20.21	.26	7.03	13.05	-	-	-	-	-	-	-	1.22
Tankage,	11	9.57	-	9.16	4.29	6.83	-	-	-	15.86	4.03	11.49	-	4.06	7.46	-	-	-	-	-	-	-	-
Fish with less than twenty per cent. water,	71	12.31	21.50	11.40	5.97	7.56	-	-	-	15.91	5.50	8.48	.55	2.64	5.06	-	-	-	-	-	-	-	2.01
Fish with between twenty and forty per cent. water.	10	30.19	20.59	7.41	4.22	5.97	-	-	-	8.32	4.68	7.09	.74	2.69	3.64	-	-	-	-	-	-	-	1.68
Fish with more than forty per cent. water,	10	45.46	15.50	7.60	2.43	4.97	-	-	-	8.56	2.94	5.08	1.17	1.33	2.58	-	-	-	-	-	-	-	1.35
Whale meat, raw,	1	44.50	1.04	-	-	4.86	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lobster shells,	1	7.27	-	-	-	4.50	-	-	-	-	-	3.52	-	-	-	-	22.24	1.30	-	-	-	-	.27
Castor-bean pomace,	6	9.68	5.70	5.72	5.22	5.51	3.40	.64	1.57	2.26	1.57	2.18	-	-	-	-	.87	.29	-	-	-	-	1.75
Cotton-seed meal,	33	6.78	5.78	7.70	4.02	6.77	2.38	.48	1.77	3.36	.73	1.65	-	-	-	-	-	-	-	-	-	-	.28
Rotten brewers' grain,	1	78.77	-	-	-	.72	-		.04	-	-	.43		-	-	-	.26	.15	-	-	-	-	.59
Mill sweepings,	1	9.49	-	-	-	3.76	-	-	.66	-	-	1.18	-	-	-	-	-	-	-	-	-	-	5.01
Tobacco leaf,	1	13.05	21.01	-	-	2.75	-	-	7.24	-	-	.43	-	-	-	-	4.17	2.17	.32	-	-	-	4.17
Tobacco stems,	7	10.61	14.07	2.91	.90	2.30	10.60	3.76	7.03	2.09	.44	.62	-	-	-	.34	3.89	1.23	-	-	-	-	.82
Cotton waste, wet,	1	34.69	-	-	-	1.30	-	-	.80	-	-	1.54	-	-	-	-	2.45	1.13	-	-	-	-	41.33
Cotton waste, dry,	4	5.87	60.60	9.33	.96	1.77	1.76	.66	1.42	1.80	.26	.45	-	-	-	-	-	-	-	-	-	-	32.59
Refuse from calico works,	1	4.07	-	-	-	4.28	-	-	-	-	-	11.95	-	-	-	-	-	-	-	-	-	-	-
Cotton dust,	1	34.46	50.93	-	-	.50	-	-	.19	-	-	.21	-	-	-	-	.90	.90	-	-	-	-	47.46
Glucose refuse,	1	8.10	-	-	-	2.62	-	-	.15	-	-	.29	-	-	-	-	.18	.02	-	-	-	-	.07
Waste from lactate factory,	1	34.11	-	-	-	.68	-	-	-	-	-	.67	-	-	-	-	22.59	-	-	-	-	-	6.92
Hop refuse,	1	8.98	-	-	-	.98	-	-	.11	-	-	.20	-	-	-	-	.27	.10	-	-	-	-	.63
Banana skins,	1	13.99	-	-	-	.24	-	-	5.46	-	-	1.80	-	-	-	-	-	-	-	-	-	-	-
Tankage and blood,	1	14.43	-	-	-	5.88	-	-	-	-	-	6.84	5.44	1.08	.32	-	-	-	-	-	-	-	-

	Analyses.	Moisture.	Ash.	Nitrogen.			Potash.			Total Phosphoric Acid.			Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
				Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.											
III. Refuse Substances — Concluded.																							
Sumac waste,	1	63.06	6.80	-	-	1.19	-	-	3.25	-	-	-	-	-	-	-	1.14	3.25	-	-	-	-	2.25
Eel-grass,	2	35.39	15.60	.96	.70	.83	1.61	.21	.91	.41	.22	.32	-	-	-	1.63	2.13	.11	-	-	-	-	1.06
Pine-barren grass,	1	8.48	2.40	-	-	.16	-	-	.07	-	-	.18	-	-	-	-	-	-	-	-	-	-	1.67
Pine needles,	1	9.48	3.42	-	-	.46	-	-	.03	-	-	.12	-	-	-	-	-	-	-	-	-	-	1.22
Rockweed, green,	1	68.50	23.70	-	-	.62	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rockweed, dry,	1	10.68	35.75	-	-	1.45	-	-	4.89	-	-	2.75	-	-	-	7.90	7.66	.21	-	-	-	-	10.40
Jute waste,	1	13.10	-	-	-	1.50	-	-	.08	-	-	.72	-	-	-	-	-	-	-	-	-	-	-
Hair waste,	1	72.81	-	-	-	1.39	-	-	.32	-	-	.61	-	-	-	-	-	-	-	-	-	-	-
Starch waste from rubber factory,	1	10.01	.23	-	-	.02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sludge from sewage precipitating tanks,	1	88.49	9.50	-	-	.05	-	-	.05	-	-	.10	-	-	-	-	1.58	.39	6.22	-	-	-	.93
Sludge,	1	6.28	-	-	-	.68	-	-	-	-	-	1.36	-	-	-	-	8.66	-	17.68	-	-	-	38.03
Residue from water filter,	1	94.22	-	-	-	.12	-	-	-	-	-	.05	-	-	-	-	-	-	-	-	-	-	-
Blue-green algæ (*Lyngbia majuscula*), dry,	1	16.26	-	-	-	4.25	-	-	.79	-	-	.19	-	-	-	3.53	2.06	1.18	-	-	-	-	5.53
Mussel mud, wet,	1	60.01	27.29	-	-	.21	-	-	6.17	-	-	.10	-	-	-	.70	.93	.14	3.48	-	-	-	-
Mussel mud, dry,	1	2.24	72.02	-	-	.72	-	-	-	-	-	.35	-	-	-	-	23.39	-	8.26	-	-	-	37.60
Madder,	2	11.93	-	-	-	.91	-	-	2.40	-	-	.35	-	-	-	-	3.93	.51	-	-	-	-	4.67

Salt mud,	2	53.37	41.19	.40	.39	.40	.33	.32	.33	-	-	-	-	-	-	.94	.91	.37	4.13	-	-	-	34.88
Fresh-water mud,	1	40.37	-	-	-	1.37	-	-	.22	-	-	.26	-	-	-	-	1.27	.29	1.80	-	-	-	18.26
Muck,	22	59.72	13.75	2.54	.26	.86	-	-	-	.17	.08	.13	-	-	-	-	-	-	-	-	-	-	11.35
Peat, wet,	11	61.36	7.66	1.40	.41	.85	-	-	.18	-	-	.09	-	-	-	-	.55	.72	2.14	-	-	-	2.14
Peat, dry,	2	14.67	17.26	-	-	1.89	-	-	.06	-	-	.03	-	-	-	-	-	-	-	-	-	-	10.14
Turf,	2	19.29	6.36	1.97	1.91	1.94	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Soot,	7	4.29	77.10	1.05	.09	.41	1.83	.21	.63	2.10	.19	1.13	-	-	-	-	2.99	1.19	6.38	-	-	-	66.06
IV. Animal Excrement, etc.																							
Barn-yard manure,	76	67.01	-	1.36	.21	.52	1.40	.13	.56	.75	.10	.39	-	-	-	-	.30	.19	-	-	-	-	8.09
Horse manure,	1	11.24	-	-	-	.74	-	-	2.82	-	-	1.46	-	-	-	-	-	-	-	-	-	-	12.60
Sheep manure,	2	50.26	-	-	-	1.15	-	-	.64	-	-	.66	-	-	-	-	-	-	-	-	-	-	12.91
Drainage from a manure heap,	1	93.20	3.66	-	-	.98	-	-	.88	-	-	.24	-	-	-	-	-	-	-	-	-	-	-
Poudrette, dry,	1	5.25	35.45	-	-	3.58	-	-	.49	-	-	5.74	-	-	-	-	-	-	-	-	-	-	4.65
Goose manure,	1	48.92	-	-	-	.21	-	-	.81	-	-	.95	-	-	-	-	-	-	-	-	-	-	-
Hen manure, fresh,	2	52.35	24.75	1.20	.79	.99	.32	.18	.25	1.00	.47	.74	-	-	-	-	1.19	.89	-	1.24	-	-	23.50
Hen-house refuse,	1	3.43	-	-	-	.98	-	-	.60	-	-	1.28	-	-	-	-	-	-	-	-	-	-	-

Average Per Cents. of Different Ingredients found in the Preceding Compilation of Analyses, calculated to Pounds per Ton of 2,000 Pounds.

	Moisture.	Ash.	Nitrogen.	Potash.	Total Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
I. Chemicals, Refuse, Salts, Ashes, etc.													
Muriate of potash,	36.	-	-	1020.	-	134.	-	11.	-	-	-	976.	14.
Sulphate of potash (high grade),	42.	-	-	1020.	-	-	-	-	-	866.	-	-	15.
Sulphate of potash-magnesia,	97.	-	-	496.	-	125.	51.	-	-	885.	-	52.	28.
Carbonate of potash,	538.	-	-	370.	-	-	-	390.	-	-	-*	-	8.
Phosphate of potash,	75.	-	-	651.	750.	-	-	-	-	269.	-	-	18.
Kainite,	64.	-	-	271.	-	379.	23.	196.	-	405.	-	665.	43.
Carnallite,	-	-	-	274.	-	153.	-	264.	-	11.	-	831.	-
Krugite,	96.	-	-	168.	-	105.	249.	176.	-	639.	-	133.	299.
Sulphate of magnesia (kieserite),	454.	-	-	-	-	-	56.	346.	-	722.	-	-	115.
Nitrate of potash,	26.	-	254.	905.	-	-	-	-	-	-	-	-	-
Nitrate of soda,	28.	-	300.	-	-	710.	-	-	-	-	-	10.	10.
Sulphate of ammonia,	212.	-	441.	-	-	-	-	-	-	1200.	-	-	-
Phosphate of ammonia,	120.	-	207.	-	877.	-	-	-	-	249.	-	-	16.
Sulphate of soda,	28.	-	-	-	-	-	-	-	-	1189.	-	-	-
Saltpetre waste,	51.	-	44.	273.2	-	740.8	15.	38.	-	37.	-	925.	-

Nitre salt-cake,	121.	-	56.	17.	-	591.	-	-	-	955.	-	-	78.
Wood ashes,	213.	-	-	107.	30.	-	712.	66.	19.	-	-	-	284.
Cotton-seed-hull ashes,	164.	-	-	455.	163.	-	186.	209.	35.	-	-	-	269.
Ashes of spent tan-bark,	97.	-	-	36.	37.	-	622.	68.	36.	-	-	-	504.
Corn-cob ashes,	24.	-	-	142.	47.	-	234.	-	26.	-	-	-	1042.
Railroad-tie ashes,	94.	-	-	18.	11.	-	50.	-	-	-	-	-	1604.
Peat ashes,	93.	-	-	9.	2.	-	46.	33.	123.	-	-	-	903.
Logwood ashes,	30.	-	-	2.	56.	-	78.	-	-	-	-	-	194.
Hard-pine wood ashes,	15.	-	-	203.	45.	-	499.	-	-	-	-	-	598.
Mill ashes,	11.	-	-	32.	9.	-	699.	27.	-	-	-	-	727.
Ashes from cremation of swill,	98.	-	-	93.	293.	-	672.	37.	.93	-	-	-	395.
Ashes from blue works,	243.	1276.	-	180.	-	-	-	-	-	-	-	-	246.
Seaweed ashes,	29.	-	-	18.	6.	175.	121.	87.	-	60.	-	132.	1273.
Gypse,	33.	-	-	-	-	-	1017.	-	-	-	-	-	57.
Nova Scotia plaster (gypsum),	173.	-	-	-	-	-	657.	15.	-	902.	-	-	69.
Onondaga plaster (New York gypsum),	265.	-	-	-	-	-	606.	93.	-	650.	164.	-	187.
Lime (burnt),	-	-	-	-	-	-	1973.	-	-	-	-	-	27.
Waste lime,	16.	-	-	-	-	-	1482.	-	-	-	-	-	8.
Gas-house lime,	446.	-	-	-	-	-	873.	166.	-	415.	-	-	121.
Lime waste from sugar factory,	726.	-	-	4.	45.	-	550.	-	-	-	-	-	6.
Lime-kiln ashes,	290.	-	-	26.	22.	-	851.	52.	-	-	355.	-	154.
Bituminous coal ashes,	144.	-	-	12.	9.	-	-	-	-	-	-	-	1370.

* Not determined.

Average Per Cents. of Different Ingredients found in the Preceding Compilation of Analyses, calculated to Pounds per Ton of 2,000 Pounds — Continued.

	Moisture.	Ash.	Nitrogen.	Potash.	Total Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
I. Chemicals, Refuse, Salts, Ashes, etc. — Concluded.													
Marls (Massachusetts),	274.	-	-	5.	21.	-	810.	13.	14.	-	571.	-	69.
Marls (Virginia),	320.	-	-	10.	2.	-	145.	4.	-	13.	145.	-	1285.
Green sand marls (Virginia),	25.	-	-	23.	187.	-	516.	-	103.	-	-	-	826.
Olive earth (Virginia),	39.	-	-	5.	275.	-	383.	-	120.	-	-	-	1011.
Ammoniated marl,	66.	-	32.	-	208.	-	-	-	-	-	-	-	-
Marl (North Carolina),	30.	-	-	1.	11.	-	439.	12.	-	-	-	-	1004.
II. Guanos, Phosphates, etc.													
Peruvian guano,	296.	752.	157.	52.	305.	-	-	-	-	-	-	-	132.
Bat guano from Texas,	802.	365.	129.	26.	75.	-	-	-	-	-	-	-	40.
Bat guano from Florida,	313.	-	195.	25.	67.	-	-	-	-	-	-	-	387.
Rat guano from Florida,	206.	-	66.	137.	46.	-	-	-	-	-	-	-	23.
Cuban guano,	485.	-	33.	-	267.	-	-	-	-	-	-	-	63.
Caribbean guano (orchilla),	146.	-	-	-	535.	-	799.	66.	-	54.	-	-	25.
Mona Island guano,	266.	-	15.	-	438.	-	750.	-	-	-	-	-	49.

South Carolina rock phosphate,	29.	-	-	-	549.	-	837.	61.	96.	-	-	-	181.
South Carolina floats,	17.	-	-	-	468.	-	-	-	-	-	-	-	403.
Florida rock phosphate,	42.	-	-	-	523.	-	608.	-	151.	-	-	-	556.
Soft Florida phosphate,	97.	-	-	-	375.	-	274.	-	136.	-	-	-	418.
Navassa phosphate,	152.	-	-	-	685.	-	749.	-	205.	-	-	-	54.
Brockville phosphate,	50.	-	-	-	704.	-	-	-	-	-	-	-	129.
Phosphatic slag,	29.	-	-	-	470.	-	973.	68.	202.	-	-	-	188.
Odorless phosphate,	60.	-	-	8.	391.	-	1028.	-	-	-	50.	-	183.
Dissolved bone-black,	206.	950.	-	-	320.	-	-	-	-	-	-	-	80.
Bone-black,	92.	-	-	-	565.	-	-	-	-	-	-	-	73.
Double superphosphate,	115.	-	-	-	956.	-	320.	-	-	24.	-	-	12.
South American bone ash,	140.	-	-	-	718.	-	898.	-	-	-	-	-	90.
Acid phosphate,	285.	1399.	-	-	293.	-	-	-	-	-	-	-	216.
III. Refuse Substances.													
Dried blood,	239.	127.	210.	-	40.	-	-	-	-	-	-	-	-
Ammonite,	118.	-	227.	-	69.	-	-	-	-	-	-	-	28.
Oleomargarine refuse,	171.	288.	242.	-	18.	-	-	-	-	-	-	-	19.
Felt refuse,	585.	671.	105.	-	-	-	-	-	-	-	-	-	-
Sponge refuse,	145.	-	49.	-	64.	-	79.	25.	-	-	-	-	781.
Blood and bone,	167.	-	135.	-	220.	-	-	-	-	-	-	-	-
Horn shavings,	99.	-	306.	-	8.	-	-	-	-	-	-	-	-
Ivory dust,	230.	1053.	133.	-	491.	-	-	-	-	-	-	-	-

Average Per Cents. of Different Ingredients found in the Preceding Compilation of Analyses, calculated to Pounds per Ton of 2,000 Pounds — Continued.

	Moisture.	Ash.	Nitrogen.	Potash.	Total Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
III. Refuse Substances — Continued.													
Horn and hoof waste,	203.	153.	265.	-	37.	-	-	-	-	-	-	-	5.
Raw wool,	139.	151.	258.	-	-	-	-	-	-	-	-	-	72.
Wool waste,	235.	582.	91.	34.	6.	-	2.	1.	16.	-	-	-	164.
Wool washings (water),	-	-	-	78.	-	10.	6.	-	-	-	-	-	-
Wool washings (acid),	-	-	-	84.	-	8.	12.	4.	-	-	-	-	-
Wool washings (alkaline),	1841.	66.	2.	22.	-	18.	1.	-	-	-	-	-	4.
Morocco factory waste,	454.	-	23.	7.	51.	-	392.	-	-	25.	-	-	483.
Meat scrap,	496.	-	127.	-	116.	-	-	-	-	-	-	-	-
Meat mass,	242.	272.	209.	-	41.	-	-	-	-	-	-	-	12.
Bone soup,	1658.	141.	23.	-	25.	-	-	-	-	-	-	-	-
Dried soup from meat and bone,	296.	168.	199.	-	11.	-	-	-	-	-	-	-	13.
Dried soup from rendering cattle feet,	216.	150.	289.	-	9.	-	-	-	-	-	-	-	5.
Dried soup from horse rendering,	1843.	-	22.	-	3.	-	-	-	-	-	-	-	-
Soap-grease refuse,	585.	1028.	64.	-	264.	-	-	-	-	-	-	-	26.
Bones,	137.	1061.	78.	-	447.	-	-	-	-	-	-	-	22.

Meat and bone,	105.	-	91.	-	404.	-	-	-	-	-	-	-	24.
Tankage,	191.	-	138.	-	230.	-	-	-	-	-	-	-	-
Fish with less than twenty per cent. water,	246.	430.	151.	-	170.	-	-	-	-	-	-	-	40.
Fish with between twenty and forty per cent. water,	604.	412.	119.	-	142.	-	-	-	-	-	-	-	34.
Fish with more than forty per cent. water,	909.	310.	99.	-	102.	-	-	-	-	-	-	-	27.
Whale meat, raw,	890.	21.	96.	-	-	-	-	-	-	-	-	-	-
Lobster shells,	145.	-	90.	-	70.	-	445.	26.	-	-	-	-	5.
Castor-bean pomace,	194.	114.	110.	31.	44.	-	17.	6.	-	-	-	-	35.
Cotton-seed meal,	136.	116.	135.	35.	33.	-	-	-	-	-	-	-	6.
Rotten brewers' grain,	1575.	-	15.	1.	17.	-	5.	3.	-	-	-	-	12.
Mill sweepings,	190.	-	75.	13.	24.	-	-	-	-	-	-	-	100.
Tobacco leaf,	261.	420.	55.	145.	9.	-	83.	43	6.	-	-	-	83.
Tobacco stems,	212.	281.	46.	141.	12.	7.	78.	25.	-	-	-	-	16.
Cotton waste, wet,	694.	-	26.	16.	31.	-	49.	23.	-	-	-	-	827.
Cotton waste, dry,	117.	1212.	35.	28.	9.	-	-	-	-	-	-	-	652.
Refuse from calico works,	81.	-	86.	-	239.	-	-	-	-	-	-	-	-
Cotton dust,	689.	1019.	10.	4.	4.	-	18.	18.	-	-	-	-	949.
Glucose refuse,	162.	-	52.	3.	6.	-	4.	.4	-	-	-	-	1.
Waste from lactate factory,	682.	-	14.	-	13.	-	452.	-	-	-	-	-	138.
Hop refuse,	180.	-	20.	2.	4.	-	5.	2.	-	-	-	-	13.
Banana skins,	280.	-	5.	109.	36.	-	-	-	-	-	-	-	-
Tankage and blood,	289.	-	118.	-	137.	-	-	-	-	-	-	-	-

Average Per Cents. of Different Ingredients found in the Preceding Compilation of Analyses, calculated to Pounds per Ton of 2,000 Pounds — Concluded.

	Moisture.	Ash.	Nitrogen.	Potash.	Total Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
III. Refuse Substances — Concluded.													
Sumac waste,	1261.	136.	24.	65.	-	-	23.	65.	-	-	-	-	45.
Eel grass,	708.	312.	17.	18.	6.	33.	43.	2.	-	-	-	-	21.
Pine-barren grass,	170.	48.	3.	1.	4.	-	-	-	-	-	-	-	33.
Pine needles,	200.	68.	9.	1.	2.	-	-	-	-	-	-	-	24.
Rockweed, green,	1370.	474.	12.	-	-	-	-	-	-	-	-	-	-
Rockweed, dry,	214.	715.	29.	98.	55.	158.	153.	4.	-	-	-	-	208.
Jute waste,	262.	-	3.	2.	14.	-	-	-	-	-	-	-	-
Hair waste,	1456.	-	28.	6.	12.	-	-	-	-	-	-	-	-
Starch waste from rubber factory,	200.	5.	4.	-	-	-	-	-	-	-	-	-	-
Sludge from sewage precipitating tanks,	1770.	190.	1.	1.	2.	-	32.	8.	124.	-	-	-	19.
Sludge,	126.	-	14.	-	27.	-	173.	-	354.	-	-	-	761.
Residue from water filter,	1884.	-	2.	-	1.	-	-	-	-	-	-	-	-
Blue-green algæ (*Lyngbia majuscula*), dry,	325.	-	85.	16.	4.	71.	41.	24.	-	-	-	-	111.
Mussel mud, wet,	1200.	546.	4.	123.	2.	14.	19.	3.	70.	-	-	-	-
Mussel mud, dry,	45.	1440.	14.	-	7.	-	1468.	165.	-	-	-	-	752.

Madder,	239.	–	18.	48.	7.	–	79.	10.	–	–	–	–	93.
Salt mud,	1567.	824.	8.	7.	–	19.	18.	7.	83.	–	–	–	798.
Fresh-water mud,	807.	–	27.	4.	5.	–	25.	6.	36.	–	–	–	365.
Muck,	1194.	275.	18.	–	3.	–	–	–	–	–	–	–	227.
Peat, wet,	1227.	153.	17.	4.	2.	–	11.	14.	43.	–	–	–	43.
Peat, dry,	293.	345.	38.	1.	1.	–	–	–	–	–	–	–	203.
Turf,	386.	127.	39.	–	–	–	–	–	–	–	–	–	–
Soot,	86.	1542.	8.	13.	23.	–	60.	24.	128.	–	–	–	1321.
IV. Animal Excrement, etc.													
Barn-yard manure,	1340.	–	10.	11.	8.	–	6.	4.	–	–	–	–	162.
Horse manure,	225.	–	15.	56.	29.	–	–	–	–	–	–	–	252.
Sheep manure,	1205.	–	23.	33.	13.	–	–	–	–	–	–	–	258.
Drainage from manure heap,	1864.	73.	20.	18.	5.	–	–	–	–	–	–	–	–
Poudrette, dry,	105.	709.	72.	10.	115.	–	–	–	–	–	–	–	93.
Goose manure,	978.	–	4.	16.	19.	–	–	–	–	–	–	–	–
Hen manure, fresh,	1047.	49.	20.	5.	15.	–	24.	18.	–	25.	–	–	470.
Hen-house refuse,	69.	–	20.	12.	26.	–	–	–	–	–	–	–	–

4. Compilation of Analyses of Fruits, Garden Crops and Insecticides.

COMPILED BY H. D. HASKINS.

1. — Analyses of fruits.
2. — Analyses of garden crops.
3. — Relative proportions of phosphoric acid, potassium oxide and nitrogen in fruits and garden crops.
4. — Analyses of insecticides.

A computation of the results of a chemical analysis of twenty prominent garden crops shows the following average relative proportion of the three essential ingredients of plant food : —

	Parts.
Nitrogen,	2.2
Potassium oxide,	2.0
Phosphoric acid,	1.0

One thousand pounds of green garden vegetables contain, on the above-stated basis of relative proportion of essential constituents of plant food : —

	Pounds.
Nitrogen,	4.1
Potassium oxide,	3.9
Phosphoric acid,	1.9

The weight and particular stage of growth of the vegetables when harvested control, under otherwise corresponding conditions, the actual consumption of each of these articles of plant food. Our information regarding these points is still too fragmentary to enable a more detailed statement here beyond relative proportions. It must suffice for the present to call attention to the fact that a liberal manuring within reasonable limit pays, as a rule, better than a scanty one. — (C. A. Goessmann.)

1. *Analyses of Fruits.*

Fertilizing Constituents of Fruits.

[Average amounts in 1,000 parts of fresh or air-dry substance.]

	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Phosphoric Acid.	Sulphuric Acid.	Chlorine.
Ericaceæ: —										
*Cranberries,	996	–	1.8	.9	.1	.3	.1	.3	–	–
*Cranberries,	894	.8	–	1.0	–	.2	.1	.3	–	–
Rosaceæ: —										
Apples,	831	.6	2.2	.8	.6	.1	.2	.3	.1	–
*Apples,	799	1.3	4.1	1.9	.3	.3	.3	.1	–	–
*Peaches,	884	–	3.4	2.5	–	.1	.2	.5	–	–
Pears,	831	.6	3.3	1.8	.3	.3	.2	.5	.2	–
Strawberries,	902	–	3.3	.7	.9	.5	–	.5	.1	.1
*Strawberries,	–	–	5.2	2.6	.2	.7	.4	1.0	–	–
*Strawberry vines,	–	–	33.4	3.5	4.5	12.2	1.3	4.8	–	–
Cherries,	825	–	3.9	2.0	.1	.3	.2	.6	.2	.1
Plums,	838	–	2.9	1.7	–	.3	.2	.4	.1	–
Saxifragaceæ: —										
*Currants, white,	–	–	5.9	3.1	.2	1.0	.3	1.1	–	–
*Currants, red,	871	–	4.1	1.9	.2	.8	.3	.9	–	–
Gooseberries,	903	–	3.3	1.3	.3	.4	.2	.7	–	–
Vitaceæ: —										
Grapes,	830	1.7	8.8	5.0	.1	1.0	.4	1.4	.5	.1
Grape seed,	110	19.0	22.7	6.9	.5	5.6	1.4	7.0	.8	.1

2. *Analyses of Garden Crops.*

Fertilizing Constituents of Garden Crops.

[Average amounts in 1,000 parts of fresh or air-dry substance.]

	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Phosphoric Acid.	Sulphuric Acid.	Chlorine.
Chenopodiaceæ: —										
Mangolds,	880	1.8	9.1	4.8	1.5	.3	.4	.8	.3	.9
*Mangolds,	873	1.9	12.2	3.8	1.3	.6	.4	.9	–	–
Mangold leaves,	905	3.0	14.6	4.5	2.8	1.6	1.4	1.0	.8	2.3
Sugar beets,	805	1.6	7.1	3.8	.6	.4	.6	.9	.3	.3
*Sugar beets,	869	2.2	10.4	4.8	.8	.6	.4	1.0	.1	–
Sugar-beet tops,	840	2.0	9.6	2.8	2.3	.9	1.1	1.2	.2	.3
Sugar-beet leaves,	897	3.0	15.3	4.0	2.0	3.1	1.7	.7	.8	1.3
Sugar-beet seed,	146	–	45.3	11.1	4.2	10.2	7.3	7.5	2.0	1.9
*Red beets,	877	2.4	11.3	4.4	.9	.5	.3	.9	–	–
Spinach,	903	2.4	16.0	2.7	5.7	1.9	1.0	1.6	1.1	1.0
*Spinach,	922	3.4	9.6	9.6	2.1	.6	.5	.5	–	–
Compositeæ: —										
Lettuce, common,	940	–	8.1	3.7	.8	.5	.2	.7	.3	.4
Head lettuce,	943	2.2	10.3	3.9	.8	1.5	.6	1.0	.4	.8
*Head lettuce,	970	1.2	–	2.3	.2	.3	.1	.3	–	–
Roman lettuce,	925	2.0	9.8	2.5	3.5	1.2	.4	1.1	.4	.4
Artichoke,	811	–	10.1	2.4	.7	1.0	.4	3.9	.5	.2
*Artichoke, Jerusalem,	775	4.6	–	4.8	–	–	–	1.7	–	–
Convolvulaceæ: —										
Sweet potato,	758	2.4	7.4	3.7	.5	.7	.3	.8	.4	.9
Cruciferæ: —										
White turnips,	920	1.8	6.4	2.9	.6	.7	.2	.8	.7	.3
*White turnips,	895	1.8	10.1	3.9	.8	.9	.3	1.0	1.0	–
White turnip leaves,	898	3.0	11.9	2.8	1.1	3.9	.5	.9	1.1	1.2
*Ruta-bagas,	891	1.9	10.6	4.9	.7	.9	.3	1.2	–	–
Savoy cabbage,	871	5.3	14.0	3.9	1.4	3.0	.5	2.1	1.2	1.1
White cabbage,	900	3.0	9.6	4.3	.8	1.2	.4	1.1	1.3	.5
*White cabbage,	984	2.3	–	3.4	.3	.2	.1	.2	–	–
Cabbage leaves,	890	2.4	15.6	5.8	1.5	2.8	.6	1.4	2.4	1.3
Cauliflower,	904	4.0	8.0	3.6	.5	.5	.3	1.6	1.0	.3
Horse-radish,	767	4.3	19.7	7.7	.4	2.0	.4	2.0	4.9	.3

Fertilizing Constituents of Garden Crops — Continued.

[Average amounts in 1,000 parts of fresh or air-dry substance.]

	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Phosphoric Acid.	Sulphuric Acid.	Chlorine.
Cruciferæ — Concluded.										
Radishes,	933	1.9	4.9	1.6	1.0	.7	.2	4.5	.3	.5
Kohlrabi,	850	4.8	12.3	4.3	.8	.4	.8	2.7	1.1	.6
Cucurbitaceæ: —										
Cucumbers,	956	1.6	5.8	2.4	.6	.4	.2	1.2	.4	.4
Pumpkins,	900	1.1	4.4	.9	.9	.3	.2	.7	.3	.4
Gramineæ: —										
Corn, whole plant, green,	829	1.9	10.4	3.7	.5	1.4	1.1	1.0	.3	.5
*Corn, whole plant, green,	786	4.1	-	3.8	.5	1.5	.9	1.5	-	-
Corn kernels,	144	16.0	12.4	3.7	.1	.3	1.9	5.7	.1	.2
*Corn kernels,	100	18.2	-	4.0	.3	.3	2.1	7.0	-	-
*Corn, whole ears,	90	14.1	-	4.7	.6	.2	1.8	5.7	-	-
*Corn stover,	282	11.2	37.4	13.2	7.9	5.2	2.6	3.0	-	-
Leguminosæ: —										
Hay of peas, cut green,	167	22.9	62.4	23.2	2.3	15.6	6.3	6.8	5.1	2.0
*Cow-pea (*Dolichos*), green,	788	2.9	-	3.1	.6	3.0	1.0	1.0	-	-
*Small pea (*Lathyrus sylvestris*), dry.	90	38.5	-	25.7	4.7	17.9	5.0	9.0	-	-
Peas (seed),	143	35.8	23.4	10.1	.2	1.1	1.9	8.4	.8	.4
Pea straw,	160	10.4	43.1	9.9	1.8	15.9	3.5	3.5	2.7	2.3
Garden beans (seed),	150	39.0	27.4	12.1	.4	1.5	2.1	9.7	1.1	.3
Bean straw,	166	-	40.2	12.8	3.2	11.1	2.5	3.9	1.7	3.1
Liliaceæ: —										
Asparagus,	933	3.2	5.0	1.2	.9	.6	.2	.9	.3	.3
Onions,	860	2.7	7.4	2.5	.2	1.6	.3	1.3	.4	.2
*Onions,	892	-	4.9	1.8	.1	.4	.2	.7	-	-
Solanaceæ: —										
Potatoes,	750	3.4	9.5	5.8	.3	.3	.5	1.6	.6	.3
*Potatoes,	798	2.1	9.9	2.9	.1	.1	.2	.7	-	-
Potato tops, nearly ripe,	770	4.9	19.7	4.3	.4	6.4	3.3	1.6	1.3	1.1
Potato tops, unripe,	825	6.3	16.5	4.4	.3	5.1	2.4	1.2	.8	.9
*Tomatoes,	940	1.7	-	3.6	-	.3	.2	.4	-	-
Tobacco leaves,	180	34.8	140.7	40.7	4.5	50.7	10.4	6.6	8.5	9.4
Tobacco stalks,	180	24.6	64.7	28.2	6.6	12.4	.5	9.2	2.2	2.4
*Tobacco stems,	106	22.9	140.7	64.6	3.4	38.9	12.3	6.0	-	-

Fertilizing Constituents of Garden Crops — Concluded.

[Average amounts in 1,000 parts of fresh or air-dry substance.]

	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Phosphoric Acid.	Sulphuric Acid.	Chlorine.
Umbelliferæ: —										
Carrots, ...	850	2.2	8.2	3.0	1.7	.9	.4	1.1	.5	.4
*Carrots, ...	898	1.5	9.2	5.1	.6	.7	.2	.9	–	–
Carrot tops, ...	822	5.1	23.9	2.9	4.7	7.9	.8	1.0	1.8	2.4
Carrot tops, dry, . . .	98	31.3	125.2	48.8	40.3	20.9	6.7	6.1	–	–
Parsnips, ...	793	5.4	10.0	.4	.2	1.1	.6	1.9	.5	.4
*Parsnips, ...	803	2.2	–	6.2	.1	.9	.5	1.9	–	–
Celery, ...	841	2.4	17.6	7.6	–	2.3	1.0	2.2	1.0	2.8

Most of the foregoing analyses were compiled from the tables of E. Wolff. Those marked * are from analyses made at the Massachusetts State Agricultural Experiment Station, Amherst, Mass.

3. Relative Proportions of Phosphoric Acid, Potassium Oxide and Nitrogen in Fruits.

	Phosphoric Acid.	Potassium Oxide.	Nitrogen.
Ericaceæ: —			
*Cranberries, ...	1	3.0	–
*Cranberries, ...	1	3.4	2.6
Rosaceæ: —			
Apples, ...	1	2.7	2.0
*Apples, ...	1	1.9	1.3
*Peaches, ...	1	1.3	–
Pears, ...	1	3.6	1.2
Strawberries, ...	1	1.4	–
*Strawberries, ...	1	2.6	–
*Strawberry vines, . . .	1	.7	–
Cherries, ...	1	3.3	–
Plums, ...	1	4.3	–
Saxifragaceæ: —			
*Currants, white, ...	1	2.8	–
*Currants, red, ...	1	2.1	–
Gooseberries, ...	1	1.9	–
Vitaceæ: —			
Grapes, ...	1	3.6	1.2
Grape seed, ...	1	1.0	2.7

Relative Proportions of Phosphoric Acid, Potassium Oxide and Nitrogen in Garden Crops.

	Phosphoric Acid.	Potassium Oxide.	Nitrogen.
Chenopodiaceæ: —			
Mangolds,	1	6.0	2.3
*Mangolds,	1	4.2	2.1
Mangold leaves,	1	4.5	3.0
Sugar beets,	1	4.2	1.8
*Sugar beets,	1	4.8	2.2
Sugar-beet tops,	1	2.3	1.7
Sugar-beet leaves,	1	5.7	4.3
Sugar-beet seed,	1	1.5	–
*Red beets,	1	4.1	3.3
Spinach,	1	1.7	3.1
*Spinach,	1	19.2	6.8
Compositeæ: —			
Lettuce,	1	5.3	–
*Lettuce,	1	7.6	4.0
Head lettuce,	1	3.9	2.2
Roman lettuce,	1	2.3	1.8
*Jerusalem artichoke,	1	2.8	2.7
Convolvulaceæ: —			
Sweet potato,	1	4.6	3.0
Cruciferæ: —			
White turnips,	1	3.6	2.3
*White turnips,	1	3.9	1.8
White turnip leaves,	1	3.1	3.3
*Ruta-bagas,	1	4.1	1.6
Savoy cabbage,	1	1.9	2.5
White cabbage,	1	4.1	1.7
*White cabbage,	1	11.0	7.6
Cauliflower.	1	2.3	2.5
Horse-radish,	1	3.9	2.2
Radishes,	1	3.2	3.8
Kohlrabi,	1	1.6	1.8
Cucurbitaceæ: —			
Cucumbers,	1	2.0	1.3
Pumpkins,	1	.6	.7
Gramineæ: —			
Corn, whole plant, green,	1	3.7	1.9
*Corn, whole plant, green,	1	2.2	2.8
Corn kernels,	1	.6	2.8
*Corn kernels,	1	.6	2.6
*Corn, whole ears,	1	.8	2.5
*Corn stover,	1	4.4	3.7

Relative Proportions of Phosphoric Acid, Potassium Oxide and Nitrogen in Garden Crops — Concluded.

	Phosphoric Acid.	Potassium Oxide.	Nitrogen.
Leguminosæ: —			
Hay of peas, cut green,	1	3.4	3.4
*Cow-pea (*Dolichos*),	1	3.1	2.9
*Small pea (*Lathyrus sylvestris*),	1	3.4	4.2
Peas (seed),	1	1.2	4.3
Pea straw,	1	2.8	4.0
Garden beans (seed),	1	1.2	4.0
Bean straw,	1	3.3	–
Liliaceæ: —			
Asparagus,	1	1.3	3.6
Onions,	1	1.9	2.1
*Onions,	1	2.6	–
Solanaceæ: —			
Potatoes,	1	3.6	2.1
*Potatoes,	1	4.1	3.0
Potato tops, nearly ripe,	1	2.7	3.1
Potato tops, unripe,	1	3.7	5.3
*Tomatoes,	1	8.7	4.5
Tobacco leaves,	1	6.2	5.3
Tobacco stalks,	1	3.1	2.7
Tobacco stems,	1	10.7	3.8
Umbelliferæ: —			
Carrots,	1	2.7	2.0
*Carrots,	1	5.7	1.7
Carrot tops,	1	2.9	5.1
*Carrot tops, dry,	1	8.0	5.1
Parsnips,	1	3.8	2.8
*Parsnips,	1	3.3	1.2
Celery,	1	3.5	1.1

4. *Analyses of Insecticides.*

	Moisture.	Arsenious Oxide.	Copper Oxide.	Acetic Acid.	Nicotine.	Mercury.	Sulphur.	Sulphuric Acid.	Chlorine.	Calcium Oxide.	Potassium Oxide.	Ferric and Aluminic Oxides.	Matter Insoluble in Hydrochloric Acid.
Paris green,	1.30	62.55	32.84	3.10	-	-	-	-	-	-	-	-	0.21
Paris green,	1.41	61.40	33.20	3.90	-	-	-	-	-	-	-	-	0.09
Paris green,	1.40	61.15	33.10	3.71	-	-	-	-	-	-	-	-	0.64
Paris green,	1.15	53.91	31.27	8.10	-	-	-	-	-	-	-	-	0.04
Paris green,	1.34	61.25	33.35	3.93	-	-	-	-	-	-	-	-	0.13
Paris green,	1.31	61.21	33.45	3.94	-	-	-	-	-	-	-	-	0.09
Paris green,	1.15	59.92	30.40	-	-	-	-	-	-	-	-	-	0.10
Paris green,	1.27	54.80	30.85	6.50	-	-	-	-	-	-	-	-	0.12
"Sulphatine,"	1.40	-	2.61	-	-	-	48.28	4.73	-	18.60	-	-	1.63
"Death to Rose Bugs,"	2.95	-	1.05	-	-	-	34.53	4.35	-	17.76	-	-	0.49
"Professor De Graff's Carpet Bug Destroyer,"	95.81	-	-	-	-	0.78	-	0.48	0.27	-	0.26	0.90	-
"Oriental Fertilizer and Bug Destroyer,"	87.14	2.38	-	-	-	-	-	.64	3.00	-	3.50	-	-
"Non-poisonous Potato Bug Destroyer,"	-	-	-	-	-	-	-	-	-	68.20	-	1.38	1.50
Tobacco liquor,	37.71	-	-	-	2.12	-	-	-	-	3.07	6.55	0.23	-
Tobacco liquor,	40.89	-	-	-	0.53	-	-	-	-	1.47	16.34	0.01	-
Tobacco liquor,	-	-	-	-	4.55	-	-	-	-	-	-	-	-
Tobacco liquor,	-	-	-	-	4.82	-	-	-	-	-	-	-	-
"Nicotinia,"	10.00	-	-	-	-	-	-	-	-	4.45	9.15	-	2.12
Hellebore,	-	-	-	-	-	-	-	-	-	-	-	-	2.34
Hellebore,	-	-	-	-	-	-	-	-	-	-	-	-	38.12
"Peroxide of Silicate,"	1.65	0.57	0.33	-	-	-	-	49.66	-	41.18	-	-	2.31

As a rule, in all preceding analyses the essential constituents are determined and stated; blanks do not imply the absence of the non-essentials.